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WOOD TURNING

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WOOD TURNING

PREPARED FOR THE USE OF STUDENTS IN MANUAL TRAINING
HIGH SCHOOLS, TECHNICAL SCHOOLS,
AND COLLEGES

BY

GEORGE ALEXANDER ROSS

INSTRUCTOR IN WOODWORK AND PATTERN MAKING, LEWIS INSTITUTE, CHICAGO

GINN AND COMPANY

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PREFACE

The object of these pages is to place before pupils such information as will be of practical help to them in their work in wood turning.

It has been the writer's experience that pupils lose confidence and become nervous because of the mishaps that are sure to occur, especially in attempting certain forms often presented early in courses of this character; and for this reason these exercises have been arranged in such a way that the turning of beads and similar work is left until such time as the confidence of the pupil is fully established; in fact, until he has had considerable experience on the lathe in handling the principal tools in connection with the simpler forms.

The course and problems are those which pupils in elementary woodwork at the Lewis Institute are required to complete during the first course in shop work, and are so arranged that each successive lesson contains a new principle closely related to those in previous exercises.

The book is intended for class work, and, as stated elsewhere in this volume, should be supplemented by instructions and demonstrations given by an instructor in charge.

This little work is sent out with the hope that it may prove of practical benefit to those into whose hands it may come.

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WOOD TURNING

The art of turning is one of the most ancient of the handicrafts, and is as important as it is ancient. The machine on which the work is performed is called a lathe.

Primitive lathes and their development.[1] The simplest form of lathe of which we have knowledge is supposed to have been constructed something like that shown in Fig. 1. Two uprights supported a crosspiece on which was fastened a tool rest. On the uprights two pieces of iron with conical points (called centers) were placed so as to support the material which was to be "turned." A rotating motion was transmitted to the material by means of a cord wound around the piece and held tight by means of the bow shown in the figure.

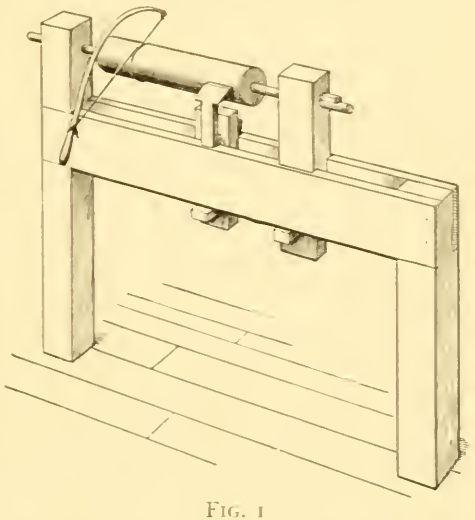


FIG. 1

By holding the bow in the left hand and applying a reciprocating motion to it, the material was made to rotate first in one direction, then in another. The tool was held in the right hand and applied to the material as it revolved toward the workman, then slightly withdrawn as it turned in the opposite direction.

This method of turning is used at the present day in Eastern countries. The workman sits on the ground and holds the tools with his toes. This allows him free use of his hands in applying motion to the material.

A slight improvement in the machine is shown in Fig. 2. By depressing the treadle which pulls down the cord, the wood is made to rotate towards the tool in

[1] Suggestions for primitive lathes from old print; author unknown.

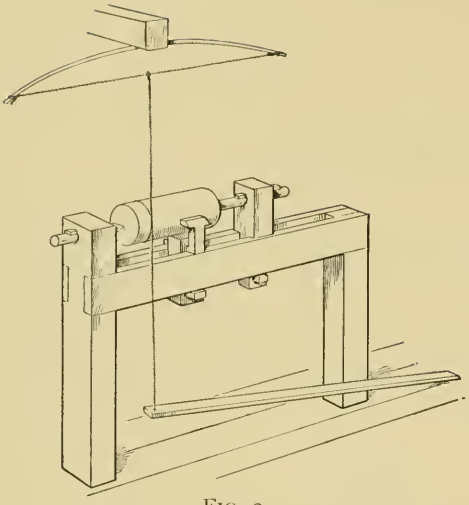


FIG. 2

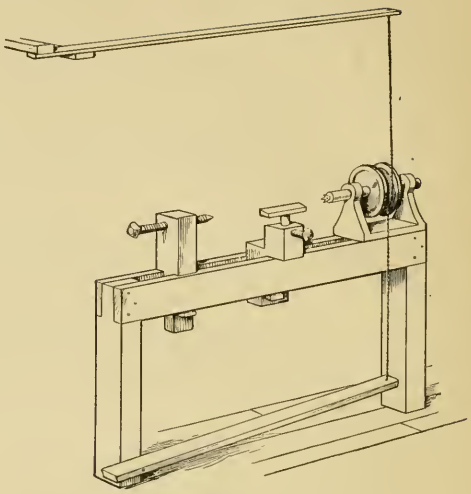


FIG. 3

the direction in which the cutting is done; and when the pressure is removed, the elasticity of the bow pulls the cord and treadle upward, ready to be depressed by the operator's foot. With this arrangement the operator was able to stand at his work, using his foot to give the article motion, thus allowing him the use of both hands to manipulate the tools.

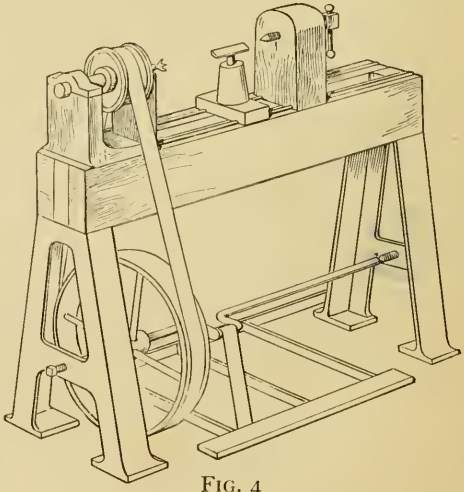


FIG. 4

In both the machines shown the driving cord was wound around the work itself. This made it necessary that the material be much longer than the article to be turned. Moreover, in such a machine there would be danger of breaking the wood (if it were small and slender) by the continued up-and-down pull of the cord.

Another step in the improvement of the lathe is shown in Fig. 3. The inconvenience arising when the cord was wound around the work doubtless led to the application of the pulley to rotate the material. The principle is the same as in

the preceding lathe. The motion is obtained by means of the treadle and cord, but the cord is pulled up by means of a strong elastic "lath." From this lath the term "lathe" is supposed to be derived.

It should be noted that in these lathes the arrangement of the cord was such that the work was made to turn toward the workman on the downward pull of the cord. In other words, the power of the workman's foot, and not the elastic lath, was used in the cutting. The inconvenience of rotating in alternate directions led, no doubt, to the next improvement shown in Fig. 4. The addition of a fly wheel in connection with the treadle, to obtain a continuous rotation in one direction, enabled the workman to cut continuously from one end of the piece to the other, and to form hollows and rounds in the work in almost any conceivable design. This lathe embodies all the principles of the modern speed lathe, except that it is driven by foot power instead of by steam or electric power.

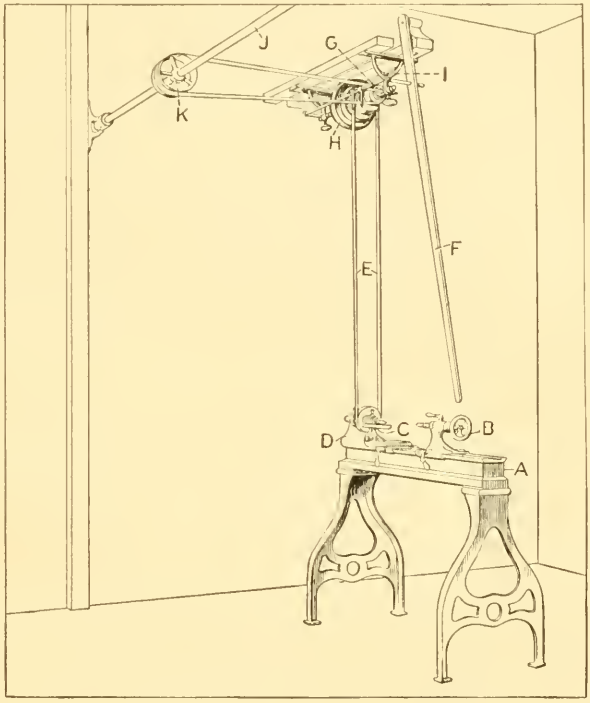


FIG. 5

The speed lathe and its parts. Fig. 5 shows a speed lathe with its parts in position. The names of the parts are as follows: *A*, lathe bed; *B*, tail stock; *C*, tool rest; *D*, head stock; *E*, belt; *F*, shifter; *G*, countershaft; *H*, cone pulley; *I*, hangers; *J*, line shaft; *K*, driving pulley. The parts not lettered are the live center, dead center, screw-center chuck, bell chuck, and face plate. (The student should know the name of each piece of the machine, so that he may be able to adjust it when told the name of the part to adjust.)

The head stock. A close study of the head stock (Fig. 6) will show that it is made up of several parts, the largest piece of which is the main casting *A*, into which the bearings *B* are fitted. In the bearings the spindle *C* revolves. It will

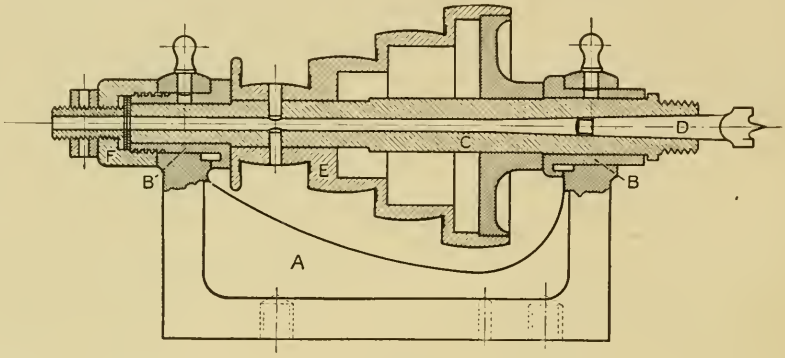


Fig. 6

be noticed that the spindle is hollow. This allows for the removal of the live center *D*, when the bell chuck *A*, screw center *B*, or face plate *C* (Fig. 7) are to be used. The live center is removed by a rod inserted at the left-hand end. The face plate and chucks are screwed on to the spindle.

The cone pulley *E* (Fig. 6) is fastened to the spindle by pins or screws, and the adjusting mechanism *F* adjusts the spindle for end thrust, so that when face plate

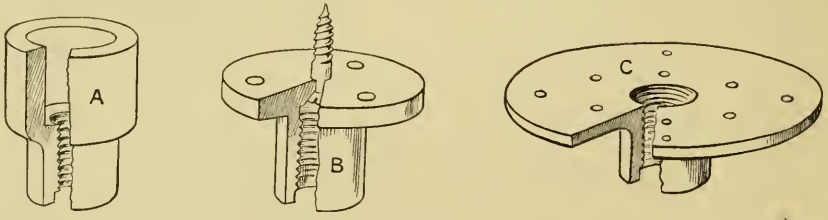


Fig. 7

or chucks are used there will be no lateral motion to the work. The oil cups, or holes, are on top of the bearings. The bearings should be oiled frequently to avoid "hot boxes."

The tail stock. The tail stock also (Fig. 8) is made up of several parts, a thorough understanding of whose functions will save much trouble. In some lathes

the casting *A* is fastened to the bed by means of a clamp, and in others by means of a hand wheel. This is placed underneath the bed in such a manner that when the wheel is turned up on a screw provided for the purpose, the tail stock will be fastened in any desirable position between the head stock and the end of the bed.

The tail-stock spindle *B* is also hollow, for two reasons: first, to give the screw *C*, which is in contact with the nut *D*, room to pass beyond the nut in order to move the spindle in and out of the tail stock; and, second, to allow the dead center *E* to be removed when necessary. It will be observed that the end of the dead center

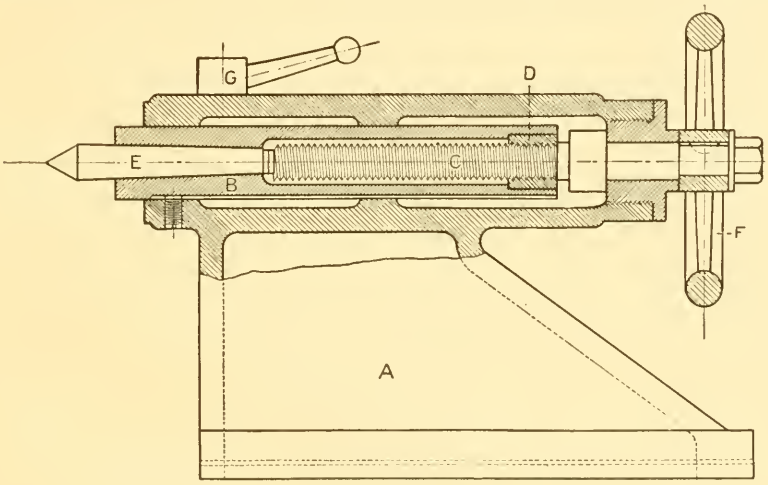


FIG. 8

projects a short distance into the chamber provided for the screw, so that when the spindle is drawn into the tail stock, the end of the screw comes into contact with the end of the dead center. This forces the dead center out of its socket and permits the center to be removed without difficulty. It will also be observed that if the screw does not enter the nut, the spindle will remain stationary, no matter how much the screw may be turned. In adjusting the tail stock, therefore, great care should be exercised in turning out the spindle, so that the nut will not be moved far enough to leave the screw. There is danger of bending the thread of the nut or screw out of shape in trying to force the spindle back into position. Should this be done, the damage can be repaired only by taking the whole tail stock apart.

The hand wheel *F* is used to turn the screw in the spindle; the clamp *G* is used to fasten the spindle in place when once set.

On the side of the spindle is a slot (not shown in the figure) into which the end of a pin or screw projects, to provide against the spindle's turning when it is drawn in or out of the tail stock.

The tool rest. The tool rest (Fig. 9) is also made up of several pieces. Its function is to provide a rest for tools when the operator is at work. The parts are the bed plate *A*, the tee-socket *B*, the clamp *C*, and the rest *D*. The manner in which the rest is fastened to the bed differs in different makes of lathes; in some it is fastened by a clamp, sometimes on the side and sometimes underneath; in others, by a hand wheel.

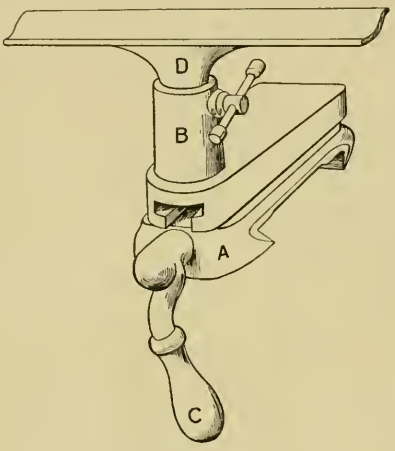


FIG. 9

The bed or shears. The bed is the main casting on which the head stock, tail stock, and rest are fastened. The bed is sometimes made of wood instead of iron. The legs are the supports on which the bed is fastened.

The countershaft. The countershaft is that part of the driving mechanism which is placed directly over the lathe. It is usually fastened to the ceiling.

The parts of the countershaft are the hangers, the tight and loose pulleys, the cone pulley, the shaft, the shifter rod, and the shifter, the end of which hangs down within easy reach of the operator (see Fig. 5).

The line shaft. The line shaft is the main driving shaft, and may be some distance from the lathe (see Fig. 5).

The belting. The driving of the lathe is accomplished by means of belts, or bands of leather, arranged in the following manner: The line shaft is driven from an electric motor or from a steam engine direct, and may turn at the rate of 150 to 400 revolutions per minute. (It has been determined by experiment that for wood turning, a speed of 300 revolutions is most satisfactory.) From a pulley on the line shaft a belt runs to the loose pulley on the countershaft. From the cone pulley on the countershaft a belt runs to the cone pulley on the lathe.

When it is desired to have the cone pulley on the lathe revolve, the shifter is moved to one side. This movement throws the belt over on to the tight pulley on the countershaft, and this, in turn, causes the cone pulley on the lathe to revolve.

The gearing of the lathe. By this term is meant the speed at which the lathe is belted to give the desired number of revolutions per minute. It will be observed from Fig. 5 how this is accomplished. On the line shaft is a pulley larger than that on which the belt runs on the countershaft. This means that the countershaft makes a greater number of revolutions than the line shaft, or, in other words, the number of revolutions is increased by the belt running from a large pulley to a smaller one.

The rules for obtaining the diameters and speeds of pulleys are as follows.

1. *The diameter and number of revolutions of the driver and diameter of the driven being given to find its number of revolutions:* Multiply the diameter of the driver by the number of its revolutions, and divide the product by the diameter of the driven; the quotient will be the number of revolutions of the driven.

2. *The diameter and revolutions of the driver being given, to find the diameter of the driven that shall make any given number of revolutions in the same time:* Multiply the diameter of the driver by its number of revolutions, and divide the product by the number of revolutions of the driven; the quotient will be its diameter.

3. *To ascertain the size of the driver:* Multiply the diameter of the driven by the number of revolutions you wish it to make, and divide the product by the revolutions of the driver; the quotient will be the diameter of the driver.

The face of a pulley for a nonshifting belt should be round or crowning, and for a shifting belt, straight. (In ordering pulleys the exact size of the shaft on which they are to go should be given.)

Motor head and gap lathes. Before passing to tools and materials we may mention the motor head and gap lathes, — lathes that have appeared on the market during the past few years.

The improvements shown in the speed lathe as compared with primitive types have been succeeded by a self-contained lathe known as a motor-head lathe. This type of lathe eliminates all overhead transmission and belts, thus giving to a shop a more pleasing appearance than belt-driven machines; also giving more light, less dust, and no danger from breaking belts or countershafts.

The lathes here shown are the product of the Oliver Machinery Company of Grand Rapids, Michigan, and selected because they are the ones with which the writer is most familiar.

In Fig. 9 A is shown a lathe, to drive which a belt is used.

Another feature of this machine is the overhanging spindle, which is used for large face-plate work. The lathes that follow are the latest designs of this type of machine.

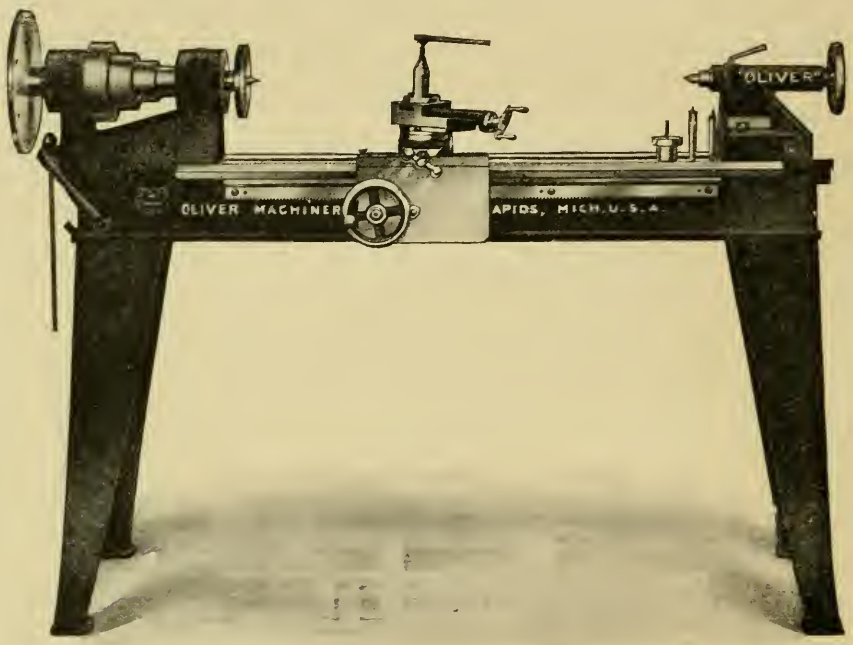


FIG. 9 A

It will be observed from Fig. 10 that the lathe is practically the same in all its features as the ordinary belted speed lathe, with the exception of the head stock or motor head, the motor taking the place of the cone pulley and overhead mechanism.

This type of lathe is so arranged that fifteen different speeds are obtained; this makes it a desirable machine in many ways. The starting box and switch fastened on the left-hand end of the bed are within easy reach of the operator, thus making control of the machine a simple matter.

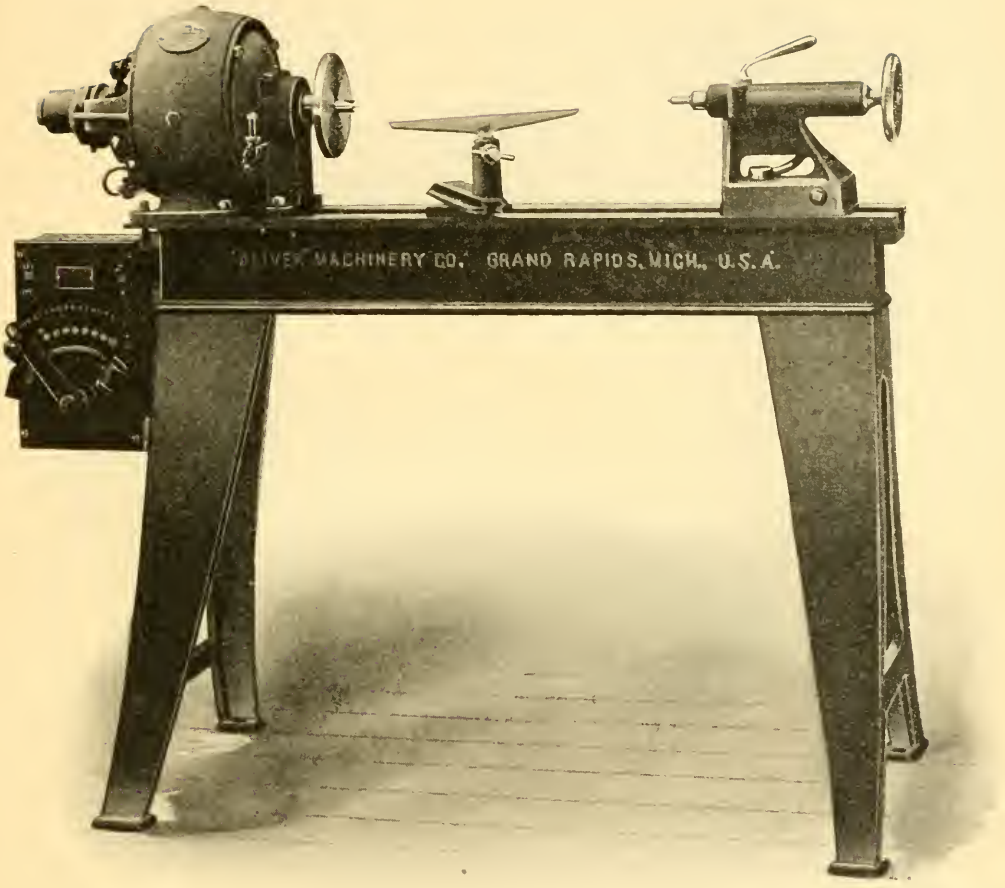


FIG. 10

An improvement on the above lathe is shown in Fig. 11, a hand feed and compound swivel rest being features that are of great help in the production of certain kinds of work, especially in a pattern shop or brass-turning room.

In this lathe the tools are held rigid in the tool post, so that the manipulation in cutting is done by turning the hand wheels on the apron and cross feed.

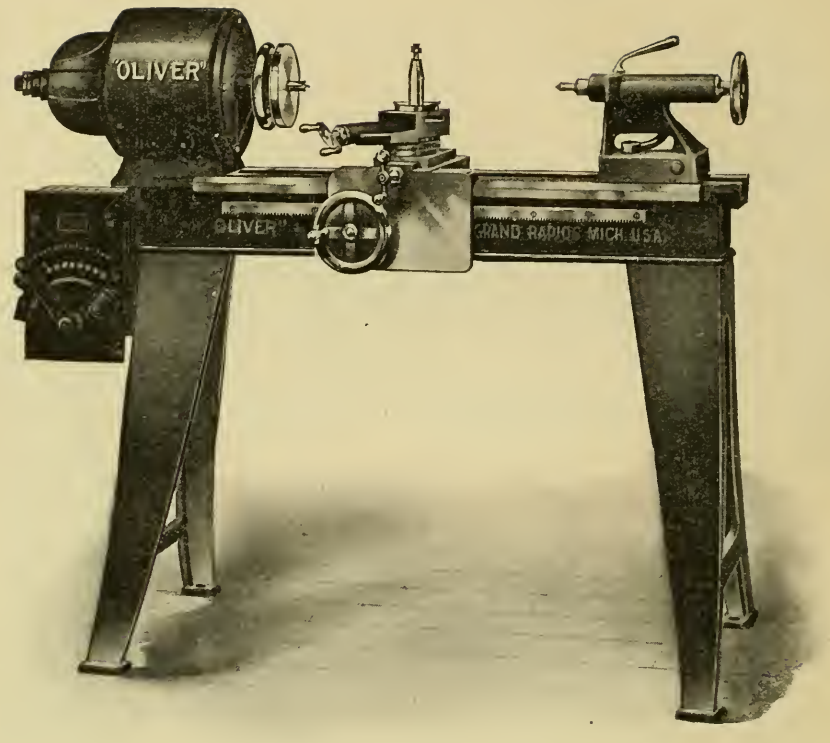


FIG. 11

In Fig. 11 A is shown another type of lathe which is a self-contained machine. From a study of the figure it will be seen that the motor has an extended armature shaft on which a cone pulley is fastened. From this cone pulley a belt is run up on to the cone in the head stock, thus eliminating the countershaft that is a feature of belted lathes. When the belt is to be shifted, the motor is raised enough to loosen the belt, so that it can be easily changed.

The switch block and rheostat are placed directly over the motor, thus in a measure protecting the motor from dust. The controlling lever is shown just above the switch, and is in easy reach of the operator, giving perfect control of the machine.

The motor on this type of lathe is arranged for alternating current.

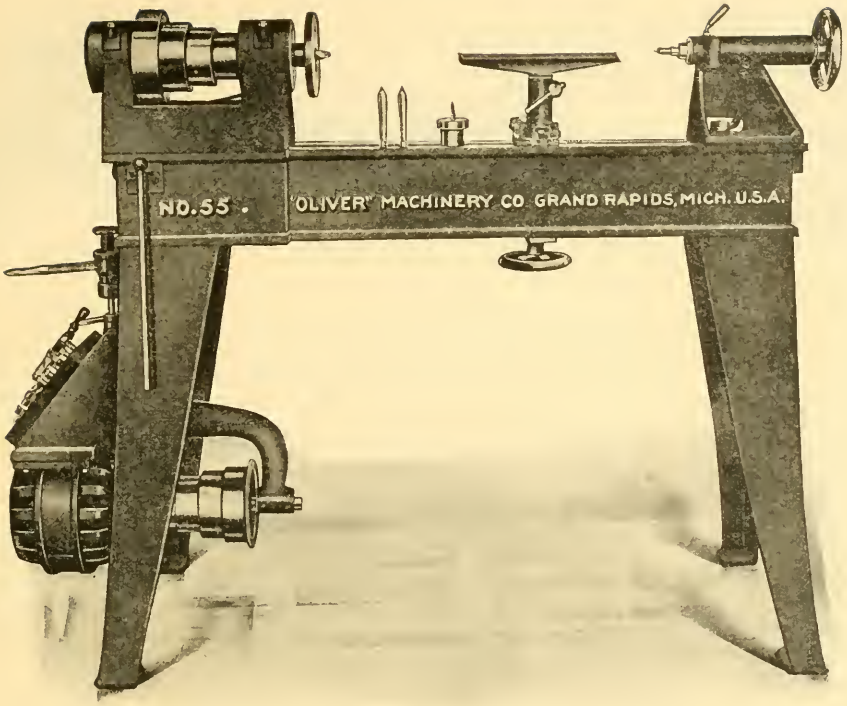


FIG. 11 A

The lathe shown in Fig. 12 is what is known as a gap lathe. Possibly there is nothing in the line of a wood-turning lathe that is more complete in itself than this machine. It can be set up as a motor-driven lathe, or a countershaft can be used in driving it.

The predominating feature of a lathe of this kind is the extension bed. This bed can be moved out to accommodate long pieces of work; the machine illustrated will take in a piece of material fifteen feet between centers and thirty inches in diameter. The opening of the gap is accomplished by means of automatic mechanism. The tail stock can be raised or set over sideways for service in taper work. The lathe is also equipped with a power feed, through cut gears and rack, which can be used with the bed in any position. The carriage has also a hand feed,

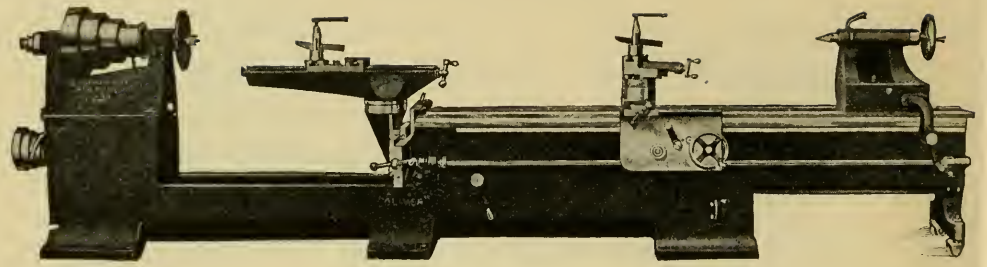


FIG. 12

while the cross slide carries a graduated compound swivel rest, which can be set at any angle. The value of this in some kinds of work cannot be overestimated when accuracy is required, and when the gap is open a piece of work eighty-six inches in length and sixty inches in diameter can be turned. This gives some idea of the capacity of a machine of this kind.

The makers of this machine claim many special features in construction, etc., and pupils studying it are referred to trade catalogues for data on lathes.

Lack of space compels us to omit a description of what are known as copying lathes, also automatic back knife lathes. For descriptions of these machines the pupil is again referred to trade catalogues.

Tools used in turning. In turning, as in any process, there is always more than one way of doing a thing, and it is often difficult to decide on the best methods of performing special operations. One workman may perform a number of operations with one tool, while another may use a tool for each operation.

The list of tools here given will be found satisfactory for ordinary wood turning; for work requiring special operations special tools will be introduced and explained.

Measuring tools: a two-foot rule; a pair of outside calipers; a pair of inside calipers: a pair of compasses.

Sharpening tools: an oilstone; a slip stone; a piece of leather used as a strop; an oil can.

Cutting tools: one $\frac{3}{4}$-inch skew chisel; one $\frac{1}{4}$-inch skew chisel; one $\frac{3}{4}$-inch turning gouge; one $\frac{1}{4}$-inch turning gouge; one $\frac{1}{4}$-inch round-nose scraping tool; one $\frac{3}{8}$-inch square-nose scraping tool; one $\frac{3}{8}$-inch diamond or spear-point tool; one $\frac{1}{8}$-inch cut-off or parting tool.

Wood turners often use what is known as a sizing tool. It is not a necessity, but it saves time where a number of pieces of the same diameter are to be cut.

Auxiliary tools: one wooden mallet; one center punch.

Extra tools for general use: one bit brace; one $\frac{1}{8}$-inch drill bit; one $\frac{3}{16}$-inch drill bit; one screw-driver; one monkey-wrench.

Before sharpening, tools are first ground to the correct shape either on an emery wheel or on a grindstone. Hence an emery wheel or a grindstone is a necessary part of the equipment.

Grinding and sharpening turning tools. The speeds at which grindstones revolve vary for different kinds of work. For general tool grinding, handbooks recommend that a stone travel between 300 and 600 feet per minute. The writer's practice has been to have the grindstone travel at about 425 feet per minute; that is, a grindstone of 36 inches in diameter should make 45 revolutions per minute.

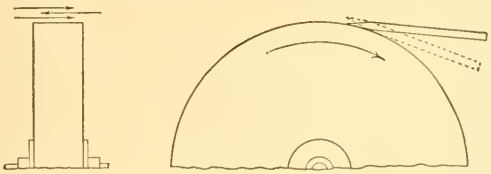


FIG. 13

To determine the number of feet which the circumference of this stone travels per minute, multiply the diameter of the stone by the ratio $\pi = 3.1416$; that is, $36'' \times 3.1416 = 113.09$, or 114. Multiply this product by the number of revolutions (45) which the stone makes per minute and divide the result by 12:

$$\frac{114 \times 45}{12} = 427\tfrac{1}{2} \text{ ft.}$$

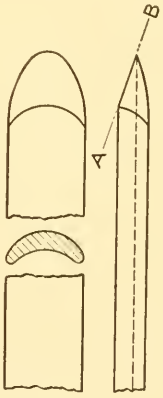


FIG. 14

To grind a tool the worker should take a position so that the grindstone is revolving toward him, and should apply the tool to the stone in such a manner that the cutting edge of the tool will not be injured by the grinding. The stone may also be used revolving from the operator.

In Fig. 13 is shown the method to be followed. Place the tool on the stone as shown by the dotted lines; then draw it back to the position shown by the full lines. The bevel will then be in contact with the stone. Then, if the tool be flat like a chisel, move it from side to side, as indicated by the arrow points in Fig. 18. This applies to tools in general.

The gouge. Of all the tools used by the wood turner there is none more commonly used than the gouge; as the jack plane is to the bench worker, so the gouge is to the wood turner.

Before grinding this tool, notice the shape it should have. The end is ground in an elliptical form, the bevel being practically a straight line, as shown at *AB*, Fig. 14.

Fig. 15

To grind the gouge, apply it to the grindstone, following the general rule given; then slowly rotate it from side to side until the end is the desired shape (see Fig. 14).

The gouge is sharpened on the slip stone. Hold the gouge in the left hand and the slip stone in the right, as shown in the illustration, Fig. 15. Oil is used on the slip stone. After the edge on the outside of the gouge has been rubbed enough, apply the round edge of the slip to the inner or concave side, taking care that the slip is in contact with the gouge the whole length of the slip. Remove the wire edge by rubbing with the slip stone and leather strop.

The skew chisel. The skew chisel is a tool commonly used to finish straight-lined work, such as the sides and ends of cylinders and cones, and in making beads and long convex curves. By referring to Fig. 16 it will be seen that the end is not a right angle, as is the case with the carpenter's chisel, but is beveled or "skewed." This beveled or skewed end is made so that the operator will have better control of the cutting edge. If it were at right angles, he would have to swing the handle so far to the side that it would be rather difficult to obtain a perfectly straight cut. As will be seen from Fig. 16, the chisel is ground on both sides, bringing the cutting edge into the center of the blade. If the tool is ground unevenly, as indicated by Fig. 17, it will be much more difficult to control. The tool is guided more by the side of the blade than by its edge; therefore, if the cutting edge is parallel with its sides, as in Fig. 16, the angle at which the tool is held for any cut is easily judged

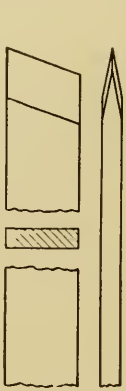


Fig. 16

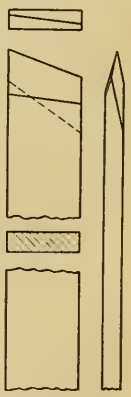


Fig. 17

by the side of the blade, whereas if the edge is unevenly ground, the angle at which it must be held can only be determined by experimentation.

Fig. 18 shows the position of the chisel on the grindstone. Apply the tool to the stone by the general rule given for grinding (page 13), and move it from side

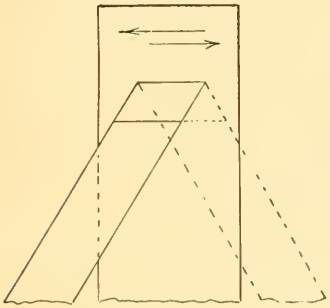


Fig. 18

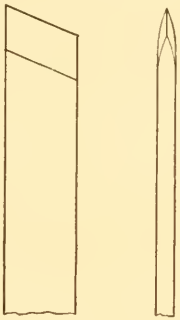


Fig. 19

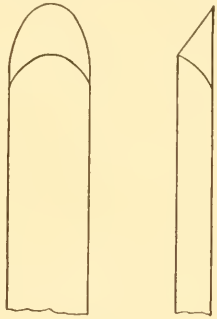


Fig. 20

to side of the stone, as indicated by the arrow points. The angle, or skew, at which to grind the end should be about 75° (see Fig. 16). The skew is sharpened on the oilstone. The bevel should be held flat on the stone, first on one side and then on the other, until the wire edge is removed. By continued sharpening the chisel becomes rounded, as shown by Fig. 19, and must be ground again. Time is saved by grinding and sharpening promptly. Tools will cut faster and smoother when the cutting edges are "keen and sharp" than when "blunt and dull."

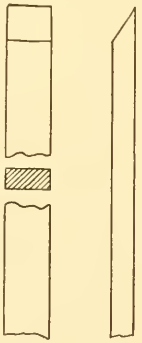


Fig. 21

The round-nose scraping tool. This tool, shown in Fig. 20, is used (as its name implies) to cut by scraping rather than by paring. It is used on fillets and concave surfaces. The method of scraping is given on page 26. Sharpen the tool on the large oilstone, revolving it in the same manner as a gouge; turn, and keep the flat side of the tool in contact with the stone. Grind it as you would the gouge.

The square-nose scraping tool. This tool (see Fig. 21) is used in the same manner as the round-nose scraping tool, and is applied on straight and convex surfaces. Sharpen it on the large oilstone, just as you would sharpen an ordinary bench chisel.

The diamond-point tool. This tool, sometimes named a "spear-point" or a "right-and-left" tool, is used on inside work or on work where the ordinary skew chisel could not be used to advantage. Fig. 22 shows the general shape it should have, but the angle can be changed to suit special work. Grind the bevels as shown in figure; sharpen on a slip stone.

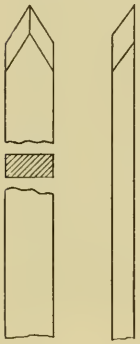


FIG. 22

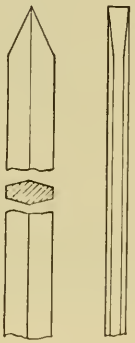


FIG. 23

The cut-off or parting tool. Fig. 23 shows this tool; as its name implies, it is used to cut off work where another tool could not be used to advantage. It is also used for "sizing" work (see Fig. 44 B as an example of its application in sizing). Grind to the shape shown in Fig. 23 and sharpen on the oilstone.

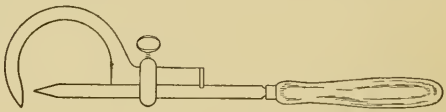


FIG. 24

The sizing tool. The sizing tool (Fig. 24) is used on work where a number of pieces are to be of the same diameter, as, for instance, the dowels on the ends of spindles, and the ends of chisel handles where ferrules are to be used. Grind and sharpen, the same as the cut-off tool.

Tools used for measuring. *The calipers.* The outside calipers (Fig. 25) are used to measure the *outside* diameters; the inside calipers (Fig. 26) are used for *inside* diameters of rings, holes, etc.

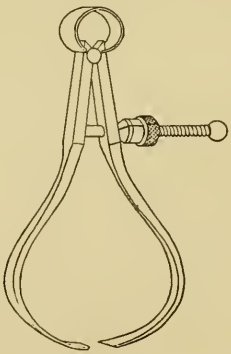


FIG. 25

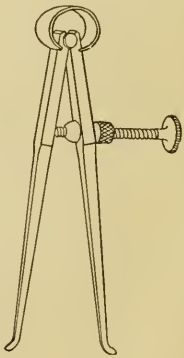


FIG. 26

The rule. A two-foot folding rule, graduated to sixteenths, makes a serviceable tool for measuring.

The dividers. The dividers (Fig. 27) are used in many ways. Their application in measuring will be given with the problems with which they are to be used.

Tools used for sharpening. *The slip stone.* The slip stone (Fig. 28) is used to sharpen gouges and tools that are curved in their section.

FIG. 27

The oilstone. Oilstones are either natural or artificial. The so-called India oilstone is preferable for ordinary sharpening. Use oil on any stone when sharpening a tool.

The strop. The strop is a piece of leather cut into such shape as to conform on its edge to the curve of a gouge. The side of the strop is used for tools that are flat or straight on the edge.

FIG. 28

Sizes of chisels and gouges. The size of a gouge or chisel is determined by its width. Turning chisels and gouges come in sizes ranging by eighths, from one eighth of an inch up to two and one-half inches.

Lathe-tool practice.[1] The art of wood turning cannot be learned from a book, but book instruction, supplemented by practice under the guidance of an instructor, will quickly enable the careful student to do good work. The exercises that follow are intended to teach the art of wood turning through various operations on the speed lathe.

EXERCISE I. TO TURN A CYLINDER

Material: Gum wood, whitewood, pine

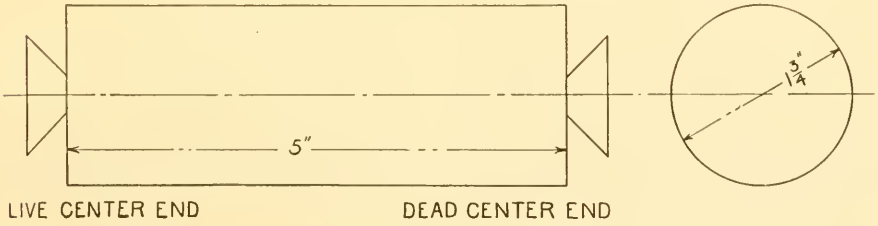


FIG. 29

No simpler form can be turned than that shown in Fig. 29. It is a plain cylinder, the dimensions of which, when finished, are $5'' \times 1\frac{3}{4}''$.

[1] Read instructions before beginning any work.

Turning makes use of two methods of cutting; namely, "paring" and "scraping." The student should give close attention to each method as it is applied in the various exercises, so that he may come to know which method is the better one to use on a given piece of work.

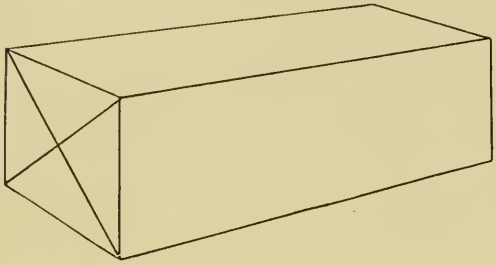


Fig. 30

To turn the cylinder. The rough stock will be $2'' \times 2'' \times 6''$, and square on the ends; by drawing the diagonals as in Fig. 30, the center of the piece will be found at the intersection of the lines. Take a center punch or some suitable tool, and mark the centers; then mount the work on the lathe.

To mount the work. Place the point of the live center in the punch mark at one end; then push the tail stock up toward the work until the point of the dead center is in the punch mark at the other end. Clamp the tail stock to the bed. Force the centers into the work by turning the hand wheel on the tail stock; then loosen up the dead center until the cone pulley and the piece of stock revolve freely. Then set the tool rest and clamp it into position. Put a little oil on the dead center, and everything will be ready for the cutting. For the paring cut, the tool rest should be set as shown at *A*, Fig. 31, and for the scraping cut, as at *B*, Fig. 31.

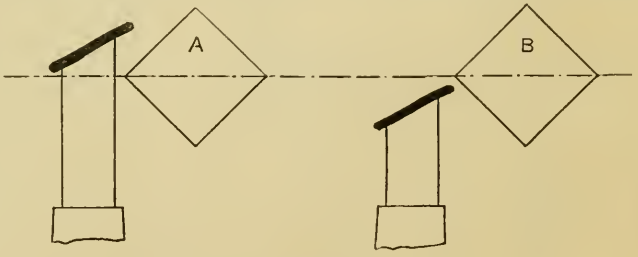


Fig. 31

The necessary steps to take in working out this exercise are shown in Fig. 32.

The first operation in turning is called "roughing down." This is done by using the gouge.

To use the gouge, notice the method of holding it, as shown in Fig. 33. The left hand, back up, is placed on top of the gouge, which is held by the third and little fingers; the right hand is at the end of the handle; the elbows are kept as close to the operator's sides as possible. The tool is now laid on the rest, the fleshy part of the hand touching the rest. The body is as nearly "square on" to the lathe

as it is possible to be, and still have a natural position when at work; it leans slightly forward, with the legs slightly apart and the left foot a little advanced. Commence cutting at the right-hand or dead-center end of the piece, and make the cut by raising the handle of the gouge with the right hand. This will cause the cutting edge of the gouge to go down into the work (see Fig. 34). By repeating the operation until the other end is reached, the corners will be cut off. A straight sweep can now be made from end to end by holding the gouge steady and swaying the body and hands. Do not twist the body or try to cut by moving the hands alone. Take one or two sweeping cuts; then try for dimensions with the calipers (see Fig. 35). Leave enough for the paring, or finishing, cut.

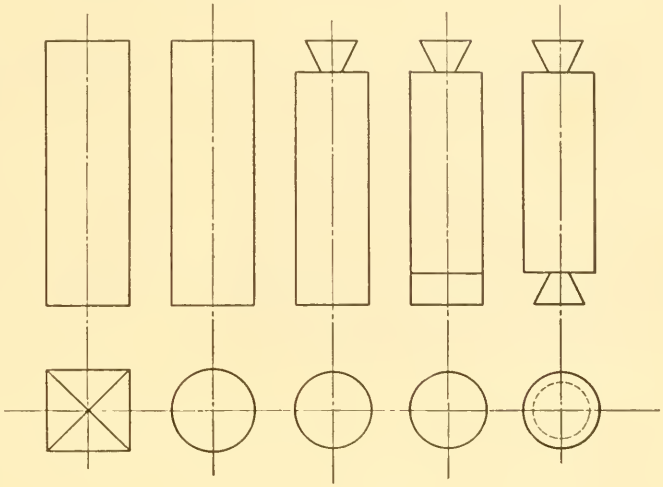


Fig. 32

Fig. 33

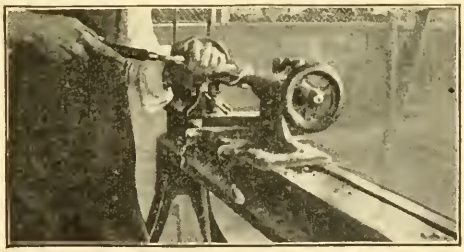


Fig. 34

The paring cut, or finishing cut, is made with the skew chisel. This cut is probably the most difficult of all for the beginner to learn, but when it is learned the greatest difficulty in turning has been overcome. The skew chisel is held in the

same manner as the gouge (see Fig. 33). In applying it, hold the bevel on the work, as shown in Fig. 36, the cutting edge held oblique to the axis of the work. The long or acute point must be kept clear of the work, and the short side of the chisel should be in contact with the rest. The angle at which the chisel is held to

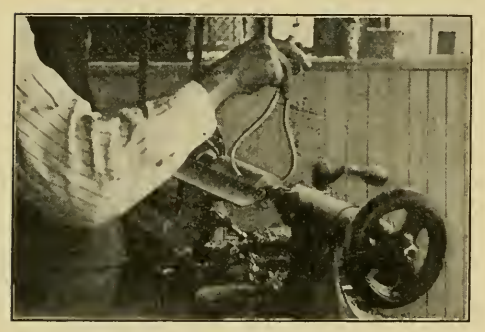


Fig. 35

Fig. 36

the axis of the lathe depends on three things: first, the amount of skew, or bevel, the chisel is ground at; second, the height of the operator; third, the adjustment of the rest on the lathe.

As stated before, the angle of the acute point of the chisel should be about 75°; the adjustment of the rest is made by the student to suit his own height.

In Fig. 36 is shown a general view of the method of holding the skew; if a student will take a jackknife and a soft piece of wood and begin to whittle it, he will observe that rarely does he hold the cutting edge of the knife at right angles to the piece, but obliquely, as in Fig. 37. Now compare the position of the edge of the knife with that of the edge of the skew chisel on the work, and it will be found that the *edges* of the two tools are held practically in the same position. In one case the material is held in the hand and the tool (knife) moves, while in the other case the material moves and the tool (chisel) is held steady in the hand.

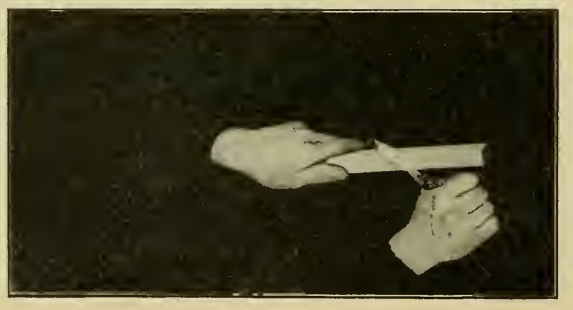


Fig. 37

For paring we repeat that the rest should be raised above the center, as shown in *A*, Fig. 31 ; and for scraping, it should be set as shown in *B*, Fig. 31. Keep the eyes on the work rather than on the cutting edge of the tool, make the sweeping cut as explained on page 19 in connection with the gouge, and hold the calipers as shown in Fig. 35 when trying for dimensions. Work from the center of the piece toward the ends, rather than from the ends toward the center. See that the dimensions are correct for diameter.

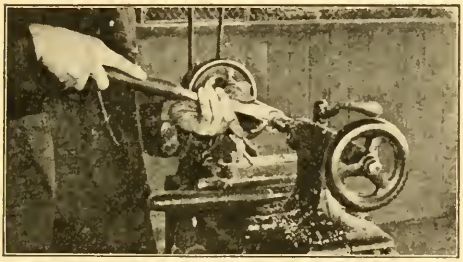


FIG. 38

To cut the ends, use the long point of the chisel. The cutting might be termed "slicing," for in paring the end wood a light cut is made so that the work will be smooth, and that the point of the tool will not be "burned," or have the "temper" drawn by the excessive friction caused by a deep or heavy cut. Finish the dead-center end *first ;* then measure the length from this, using a pencil and rule or a pair of compasses. Fig. 38 illustrates the method of holding the chisel for the cut at the right-hand or dead-center end.

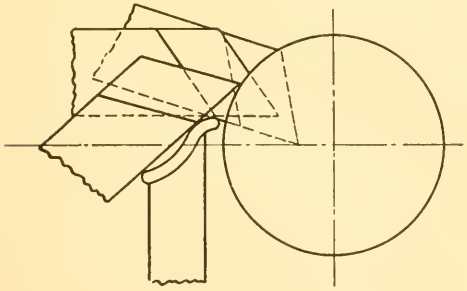


FIG. 39

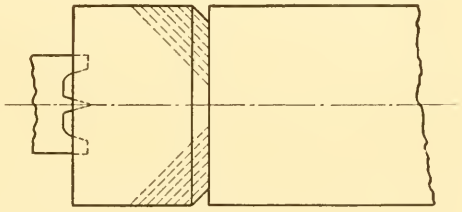


FIG. 40

The piece should be cut far enough *in* from the end so that the "center marks" shall not be on the finished work. Fig. 39 indicates the motion the chisel should have in making the end cut. At the left hand (the live-center end) the cutting should be done as indicated in Fig. 40.

After the ends are finished and the cylinder is cut to the correct length, remove from the lathe and saw off the surplus material at the bench.[1]

[1] No sandpaper is to be used, unless specified for given exercises.

EXERCISE II. TO TURN A STEPPED CYLINDER

Material: Gum wood, whitewood, pine

This exercise begins in the same manner as the first one; the necessary steps to take in working this out are shown in Fig. 42. After the piece is turned to a cylinder and marked with the dividers, as at *C*, Fig. 42, proceed to cut off the surplus stock with the gouge, as indicated by dotted lines at *C* in Fig. 42. Then *pare* to dimensions given in the working drawing (Fig. 41). (Care should be taken in

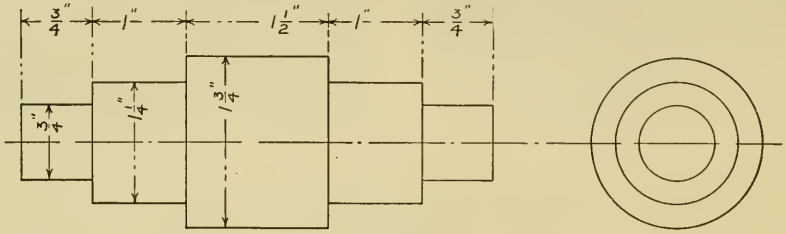


FIG. 41

cutting the ends. Do not cut to the line at first when cutting with the skew chisel, but leave a little to make a finishing cut.) The method of cutting the ends is the same as shown in Figs. 39 and 40.

The end steps of the cylinder are now marked and pared off as in *E* and *F*, Fig. 42; the final cutting in the lathe is as shown at *G*, Fig. 42. Saw off the live-center and dead-center ends and finish at the bench.

EXERCISE III. SOCKET CHISEL HANDLE

Material: Apple wood, hickory

All work turned on the lathe on centers is commenced in the same manner as in Exercises I and II. It will be unnecessary in this manual hereafter to repeat the preliminary operation for mounting the work on centers on the lathe, roughing down, etc.

In Fig. 43 is shown the working drawing. In procuring the stock have it a little longer than the finished exercise, and before commencing the work lay out your plan of procedure.

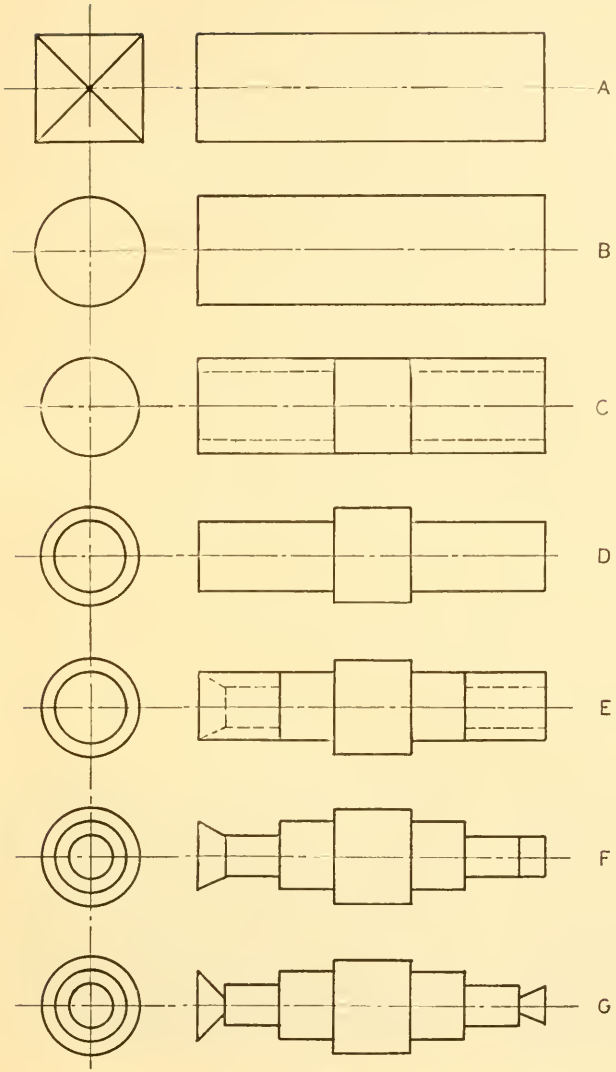


FIG. 42

As the chisel handle is intended for a socket chisel, it would be advisable to have a chisel in which to fit the end, since all chisels are not of the same taper. If the chisel is not at hand, and the handle is to be used later, leave the live-center end on the handle, so that it can be replaced in the lathe and fitted into the chisel. The dead-center end will not be cut as in Exercises I and II, but this end of the piece will be the point to measure from.

The operation, after the piece is turned to a cylinder, will be understood from Fig. 44 A and Fig. 44 B. This is known as "sizing." Take the cut-off tool and size the several diameters, as shown in the illustration; then finish the outline of the handle with the gouge and chisel. Finish the work with sandpaper. In using sandpaper care should be taken not to cut away sharp corners. Hold the sandpaper (after folding it in a narrow strip) on the work by the index and middle fingers and keep it moving back and forth; the quicker the motion the better, as then no

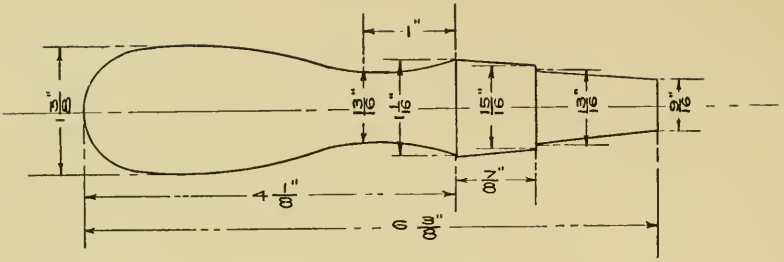


FIG. 43

rings will be left in the work. Use No. 1½ sandpaper at first, then No. ½ or No. 0. After the work is sandpapered sufficiently, apply a coat of shellac varnish, brushing it on while the lathe is at rest. Then take a dry cloth, start the lathe, and wipe

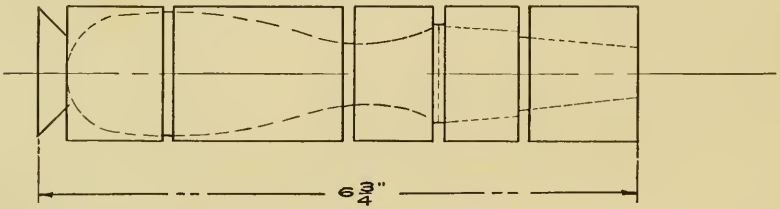


FIG. 44 A

off the surplus shellac. Care should be taken that the cloth does not stick and get wound on to the work. Fig. 45 illustrates the method of using the cloth.

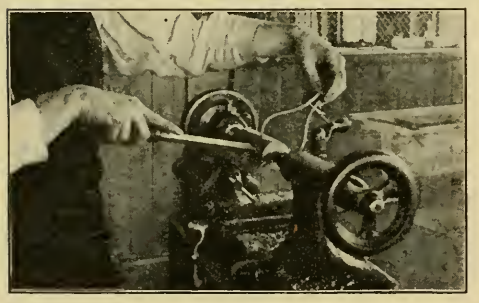


FIG. 44 B

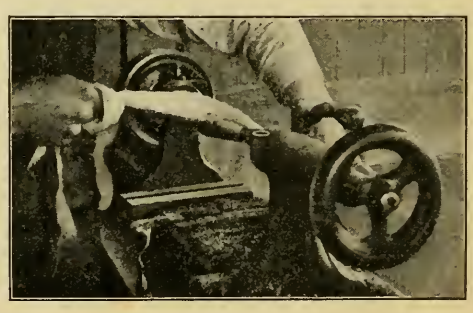


FIG. 45

This method of finishing gives fairly good results, *but it is not intended to imply that this is the only method of finishing.* Other methods will be given later.

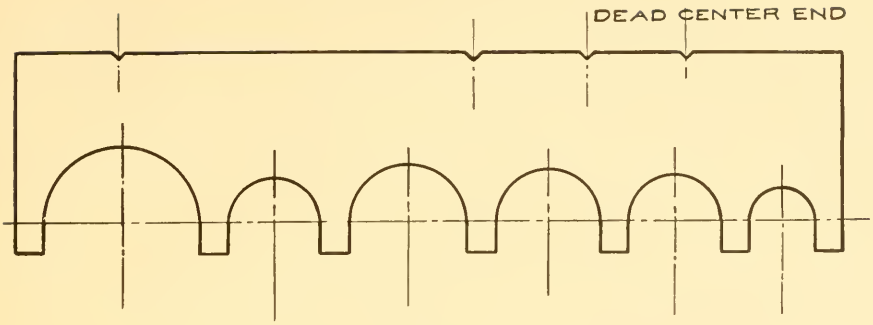


FIG. 46

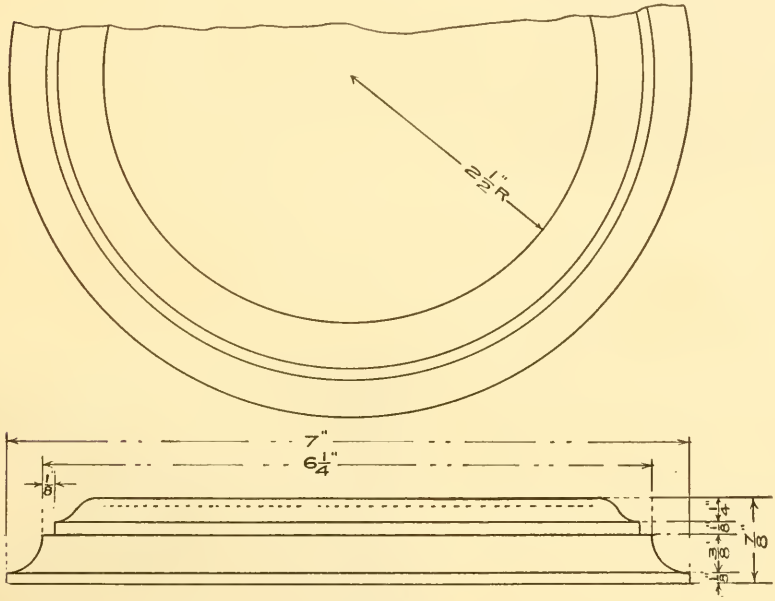


FIG. 47

When a number of handles are to be turned, time will be saved by making a templet such as is shown in Fig. 46. The several diameters are cut on one edge of a piece of thin sheet iron, and notches are filed on the other edge to locate the positions to be cut while sizing.

EXERCISE IV. TEAPOT STAND

Material: Oak, mahogany, cherry, ash, or any hard wood that will finish well

In Fig. 47 is shown the working drawing for this piece of work. The methods used are applicable on such work as rosettes and similar pieces.

The previous exercises were turned on the centers, that is, the piece was supported on the lathe by the live center and dead center. In the present exercise the screw-center chuck *B*, Fig. 7, is used. The method of cutting is termed "scraping."

FIG. 48

The scraping cut. This cut is made by laying the chisel flat on the rest instead of tilting it up, as in the paring cut. The chisel should be kept sharp and the scraping or cutting should be done lightly in order to obtain a smooth surface. To fix the rest for this piece and to turn the disk, see the illustrations, Figs. 48 and 49. These illustrations show the piece with the corners cut off, the rest set across the face, and the skew chisel in position for cutting off the corners and squaring up the edge.

The diameter of the disk can be measured off with the compasses. Start the lathe; set the compasses to the radius and place one point on the center of the piece, bringing the other point down on the rest and pushing it against the face of the piece. The line will be marked while the piece is revolving.

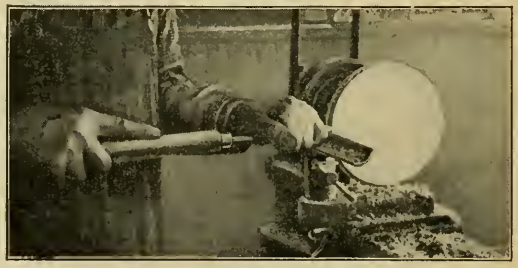


FIG. 49

The back corner of the piece is liable to split off if the chisel is pushed all the way across, so that about $\frac{1}{8}$ of an inch should be left uncut; then set the rest across the edge (see Fig. 49), cut off the material with the gouge, and scrape smooth with the skew chisel.

When the piece is turned to diameter "face it off," that is, smooth the side by using the skew chisel. (The rest should be set across the face.) Move the chisel from the edge *in* toward the center, and back again toward the edge. A "straight edge" should be used to test the work for "trueness."

To turn the molding on the edge, use the round-nose scraping tool for the concave curve and the square-nose or skew chisel for the convex curve. When all the cutting is done, finish the piece with sandpaper; then apply a coat of wood filler (see note on wood filler in Appendix), let it set a few minutes, and then wipe it off with waste or excelsior; let the filler harden, and the work will be ready for polishing. To polish, use a rag on which are a few drops of linseed oil and shellac, and apply while the work revolves on the lathe. Be careful not to get too much oil or shellac on the work. If too much shellac is used the work will appear smeary, and if too much oil is used it will appear greasy.

EXERCISE V. CANDLESTICK

(Templet and Chucking Exercise)

Material: Whitewood, birch

From the illustration, Fig. 50, we see that there are two pieces to be turned for this article. The upright (Fig. 51), which is turned first, is mounted on the lathe on "centers." The cutting of this piece will be paring. In previous exercises the method of paring was explained for straight work; in this exercise there are convex and concave curves to be cut. The method of cutting concave curves

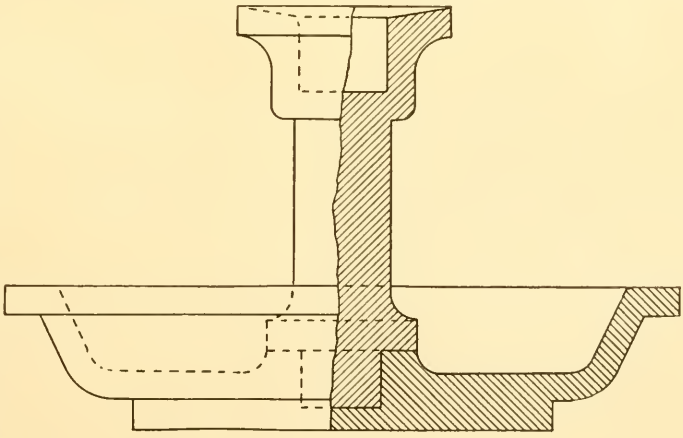


Fig. 50

will be understood from the illustration, Fig. 52. The necessary steps in working out this part of the exercise are shown in Fig. 53. To cut the concave curves, use the small gouge and cut, as shown in Fig. 52, which shows three positions. Make a clean, smooth cut. For the convex curve use the small skew chisel. (See Fig. 54, which shows the method of cutting.) It would be advisable for the student to practice cutting the curves on a waste piece of stock before trying the exercise. In cutting the curves swing the handle of the chisel or gouge with a full movement. Notice that if the tools slip and dig into the work, it is due to the fact that they are held in one direction while the student is trying to make them cut in another. Make

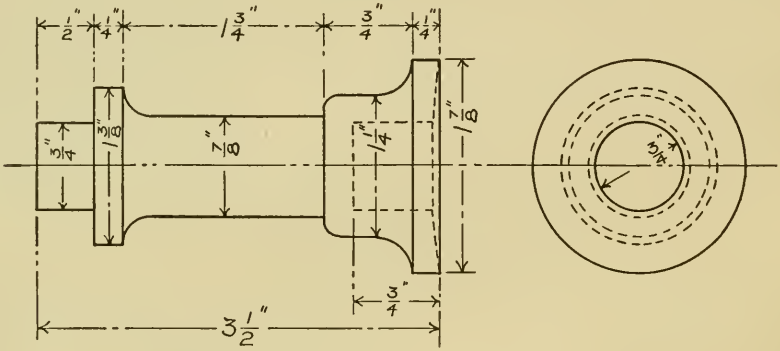


Fig. 51

the direction of the tools correspond with the direction of the cut. *The hole in the end is turned after the piece has been fastened with glue into the base.*

To turn the base (Fig. 55) a face plate (see *C*, Fig. 7) is required, and as no screw holes are to be left in the work when finished, a study of the method of operations is necessary.

The stock from which the base is turned is fastened with screws to the face plate; the side nearest the face plate will be the top or upper side when the piece is finished, so that the bottom side of the piece will be turned first. The edge is cut in the same way as explained in Exercise IV.

In order that the wall may be of equal thickness, "templets" are used. A templet is a form or pattern cut out of thin material, and is used on the work as shown in Figs. 56, 59.

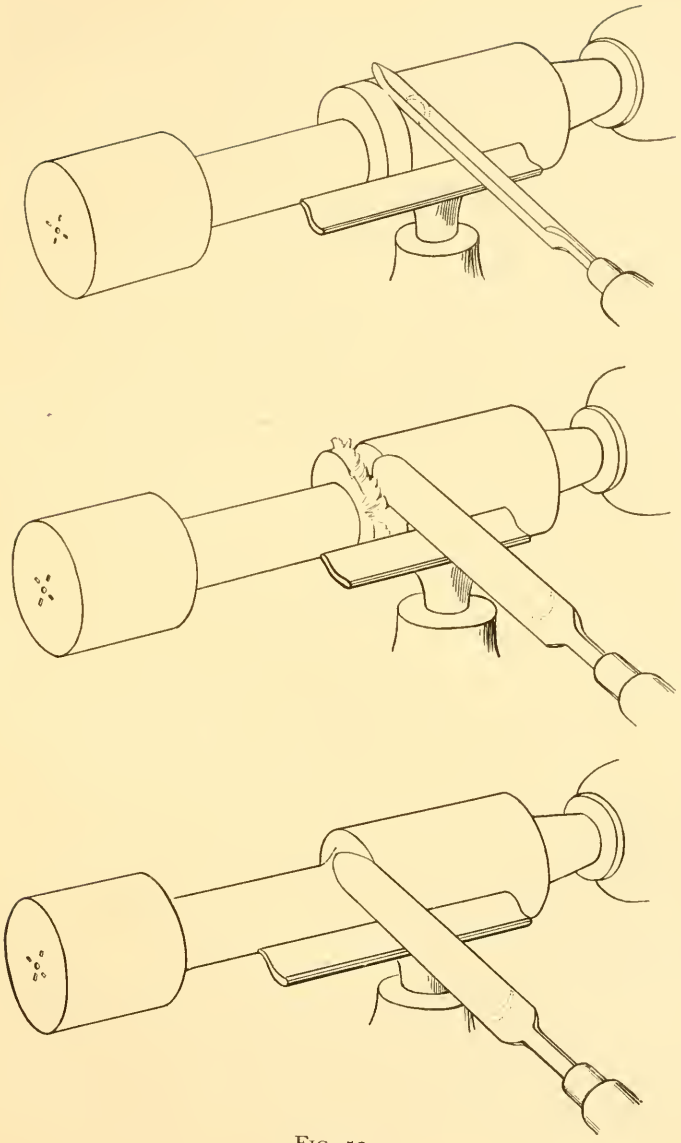


FIG. 52

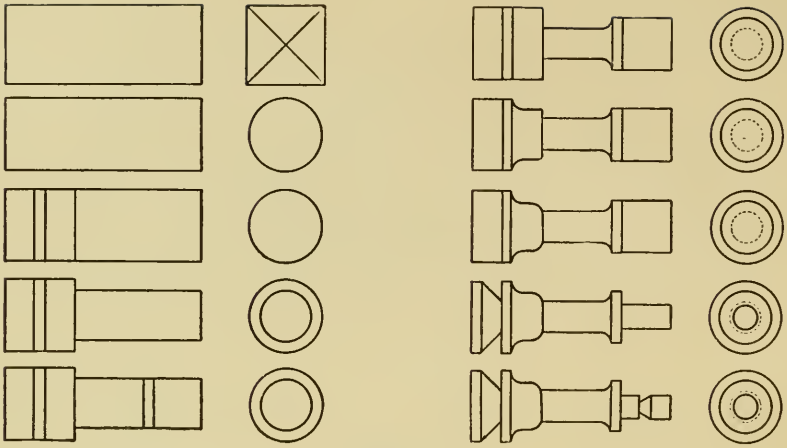


FIG. 53

To make the templets. To make the templets, lay them out as illustrated in Fig. 57. Use a coping saw to cut the two templets apart, then finish up to the lines by using a sharp knife. After the templets are cut out and the work mounted on the lathe, cut the edge of the piece to its largest diameter, and then "face it off," using the large skew chisel to cut with. The next step would be to cut the bottom to its diameter and depth (see *B*, Fig. 56), using the skew chisel in cutting. After the bottom member has been cut into shape, cut the side, using the templet to get the correct shape. In using the templet notice that there are two points, *A* and *B*, that are used as guides (see Figs. 56 and 59). The tools used to cut the side should be the round-nose scraping tool and the skew chisel. When all cutting on the outside is done, sandpaper the work smooth, and color with some of the stains described in the Appendix. One of the dark stains would be all right for this article.

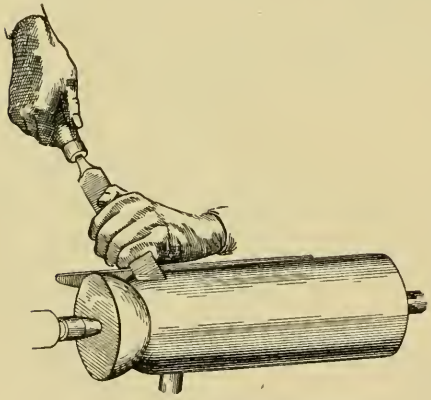


FIG. 54

The finish should be either shellac or wax. To finish with shellac, the work can be either a rubbed finish, like Exercise IV, or a two-coat finish and rubbed with pumice and oil, or water (see Appendix). The wax finish is applied with a rag and is left to dry for a short time, and is then polished with a dry, soft cloth, while the lathe is in motion.

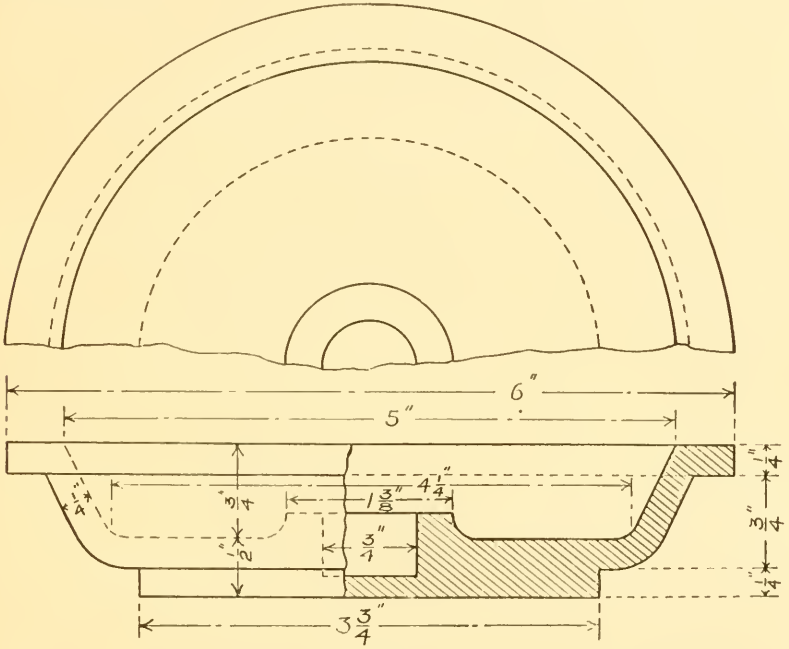


FIG. 55

When the surface is finished the work is taken off the face plate and "chucked"; that is, the work has to be turned around so that the side which was against the face plate would be out. To do this, a piece of wood is fastened on the face plate and a recess is turned into it, as shown in Fig. 58. The piece of work is held in the chuck by friction, a good tight fit being all that is needed to hold it. This operation is termed "chucking." When the piece is chucked and the work revolves true, commence to cut it out, using the round-nose scraping tool; then finish with the square-nose scraping tool or the skew chisel.

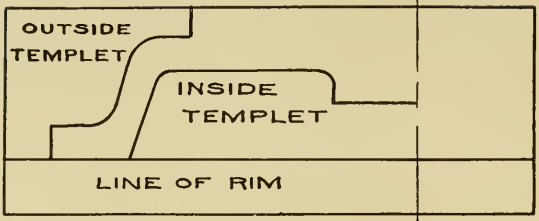


FIG. 57

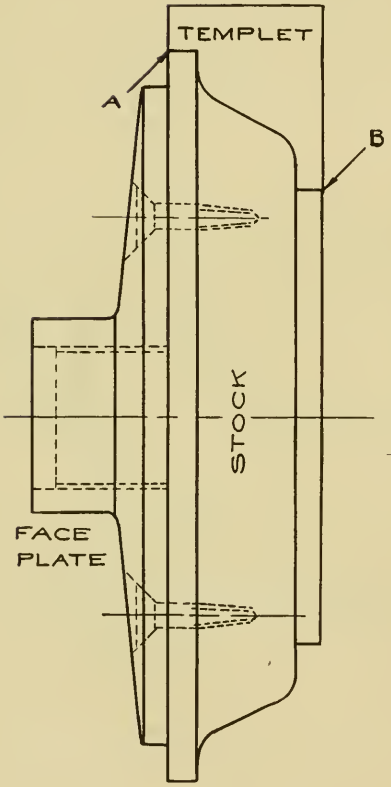


FIG. 56

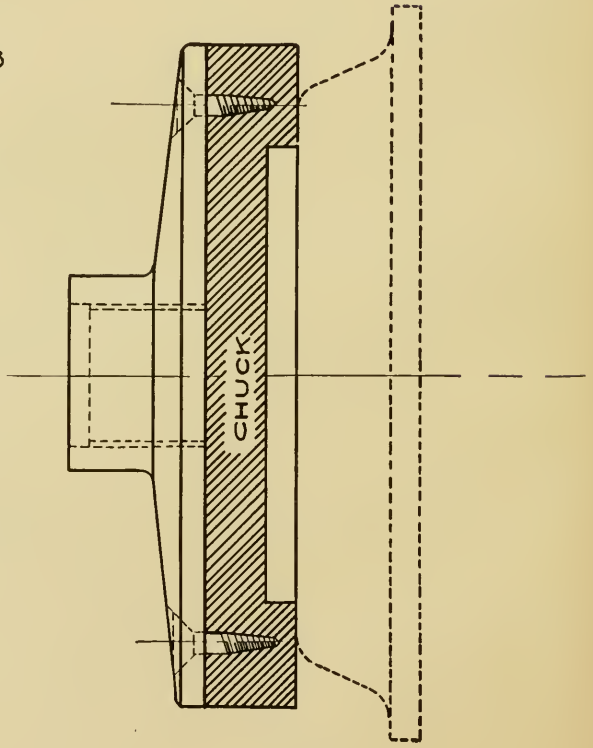


FIG. 58

The templet applied to the work is shown in Fig. 59. After the piece has been cut into shape, turn the hole in the hub as shown in the working drawing, fit and glue the upright in place, being careful that it is fastened true; when the glue is dry, turn the hole (which holds the candle); sandpaper the work smooth, and "finish" the same as the other side.

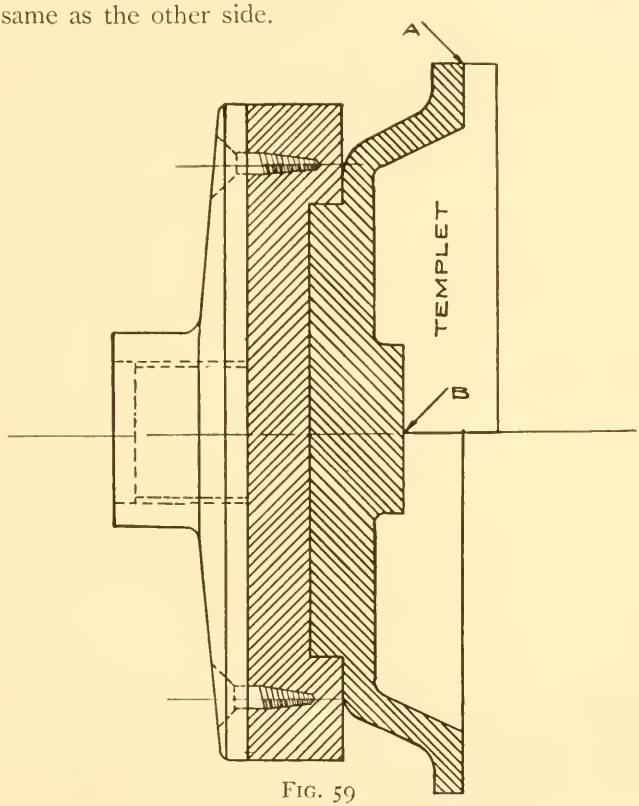


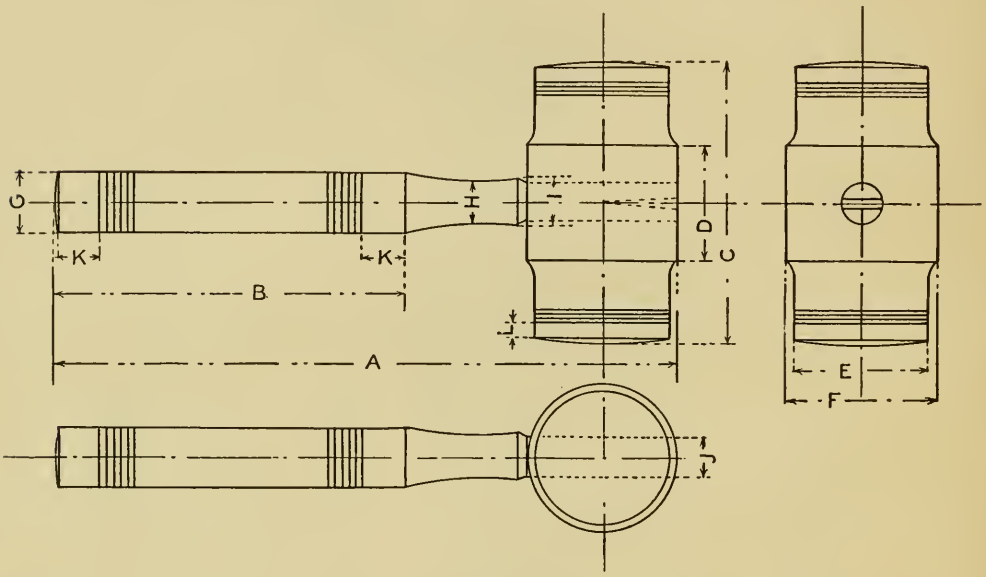
FIG. 59

The principles underlying work of this character are very important to the student who intends to take up pattern making; the principles and methods are applied extensively in the turning of patterns. As a supplementary lesson the student should be encouraged to design pieces of work in which the same principles are applied as that given in connection with the candlestick; that is, a piece that would require templets and also chucking to work it out.

EXERCISE VI. MALLET

Material: Apple wood or hickory

The general drawing, Fig. 60, is what is termed a tabulated drawing; letters instead of figures are used on the drawing. To obtain the dimensions of any of the mallets numbered 1, 2, and 3, look along the space opposite the number and under the letter, where the dimension will be found.



NO.	A	B	C	D	E	F	G	H	I	J	K	L
1	$11\frac{1}{2}$"	$5\frac{1}{2}$"	$5\frac{1}{4}$"	$2\frac{3}{16}$"	$2\frac{1}{8}$"	$2\frac{3}{8}$"	1"	$\frac{11}{16}$"	$\frac{13}{16}$"	$\frac{5}{8}$"	$\frac{3}{4}$"	$\frac{3}{8}$"
2	12"	$6\frac{3}{8}$"	$5\frac{1}{2}$"	$2\frac{1}{4}$"	$2\frac{3}{8}$"	$2\frac{5}{8}$"	$1\frac{1}{16}$"	$\frac{3}{4}$"	$\frac{7}{8}$"	$\frac{3}{4}$"	$\frac{3}{4}$"	$\frac{3}{8}$"
3	$12\frac{1}{2}$"	$7\frac{1}{4}$"	$5\frac{3}{4}$"	$2\frac{5}{16}$"	$2\frac{5}{8}$"	$2\frac{7}{8}$"	$1\frac{1}{8}$"	$\frac{13}{16}$"	$\frac{15}{16}$"	$\frac{7}{8}$"	$\frac{3}{4}$"	$\frac{3}{8}$"

FIG. 60

There is no doubt that a much smoother piece of work can be obtained from the paring cut than from the scraping cut. In working out this problem, use the paring cut on the handle and the scraping cut on the head.

First turn the handle to its largest diameter; then turn that portion of it which goes through the head, and, instead of using the calipers for the diameter, use a gauge made out of thin stock. The gauge is shown in Fig. 61.

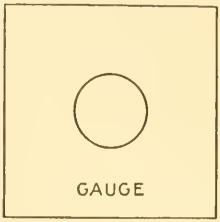


Fig. 61

To make the gauge. The hole is bored with an auger bit corresponding to dimensions given in the table. The gauge is hung on the dead center so that it will not be necessary to remove the work from the lathe when trying for size. Leave this part of the handle a little longer than the diameter of the head so that it may be finished off flush when the mallet is put together.

In cutting the curve on the handle, notice that it is a long curve and not a series of curves. The curve is cut with the gouge. The lines on the handle are decorative, and are cut with the point of the skew.

When all cutting is done, sandpaper smooth, give a coat of shellac, lay it aside to dry, and before fitting it into the head, put it back into the lathe and smooth off the shellac with fine sandpaper.

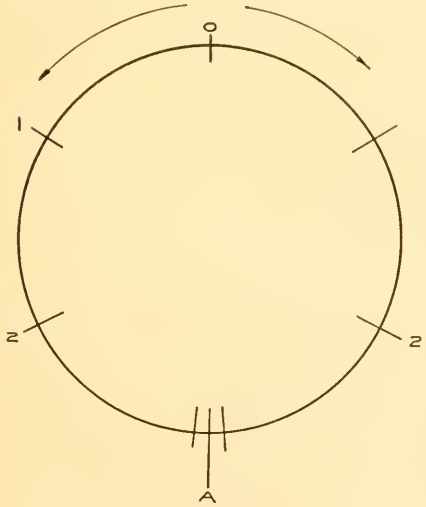


Fig. 62

To work out the head. After turning the cylinder to the largest diameter, mark the center line with the chisel point, then measure equal distances on each side of it. Possibly the only point that need be mentioned is the "fillets," that is, the small curves where the two diameters meet. These can be cut with the small gouge or round-nose scraping tool; in cutting the ends, use the parting tool. The lines on the head are also decorative and are cut in the same way as those on the handle. When the head is turned, finish in the same manner as the handle, with sandpaper and shellac.

To fasten the handle into the head. That part of the handle which fits into the head should be split with a saw cut, about half its length; the hole in the head should be bored true. To get the hole true, points should be marked on each side and the hole bored in from these points.

To locate the points to bore for the handle. To lay out the hole, take a compass and set it to the radius of the larger circle, that is, largest diameter. Commence at a point selected on the center line and space off three spaces on one side, then go back to the starting point and space off three spaces on the other side. Most likely it will be found that in spacing, the points will not meet (see *A*, Fig. 62). Divide this space equally; this will give the point on which to bore; the first point will be the point to bore on the other side.

In boring, it might be well to have some one to "line up" the bit, that is, to see that the bit is held at right angles to the axis of the cylinder. When the hole is bored, drive the handle into the head and fasten it in with a wedge, having the wedge in the position shown in the drawing.

The next step is to trim and smooth all ends and finish with shellac. Two coats of shellac will be sufficient.

EXERCISE VII. CANDLESTICK

Material: Mahogany, birch, cherry, oak, or maple

This piece of work (Fig. 63) is made of two parts; the upright being turned between centers and the base on the screw chuck.

In turning the beads on the upright, care should be taken while using the chisel, so that it will not slip. Roll the chisel to follow the curves with a full swing. In cutting beads, it might be well for the pupil to practice on a waste piece; some of the miscellaneous exercises given at the end of this manual could be selected for practice.

The base is cut plankwise of the stock in the same manner that the base in Exercise V is cut. The hole in the top is turned after the upright is fastened into the base.

An ebony, or any of the dark stains, is peculiarly appropriate for this piece of work.

EXERCISE VIII. NAPKIN RINGS

(Bell Chuck Work)

Material: Birch, maple, apple, or any close-grained hard wood

The methods of turning, given in connection with this exercise, are applicable to hollow work, such as cups, vases, etc.

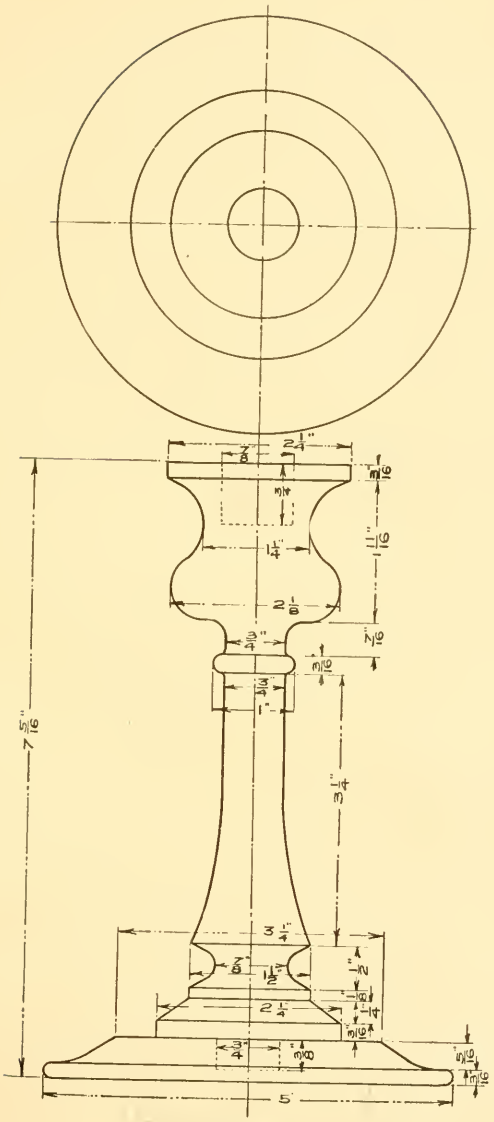

2 1/4"
7/8"
3/16"
3/4"
1 1/4"
1 11/16"
2 1/8"
3/4"
7/16"
3/16"
3/4"
1"
7 5/16"
3 1/4"
3 1/4"
7/8"
1 1/2"
1/2"
1/8"
2 1/4"
1/4"
3/16"
3/4"
3/8"
5/16"
3/16"
5"

FIG. 63

First, the stock is placed in the lathe between centers and turned to a cylinder. The end of the cylinder is then turned down small enough so that it can be driven into the bell chuck (see *A*, Fig. 7). The bell chuck is then screwed on to the spindle of the lathe, and the interior of the napkin ring is turned out. Use the

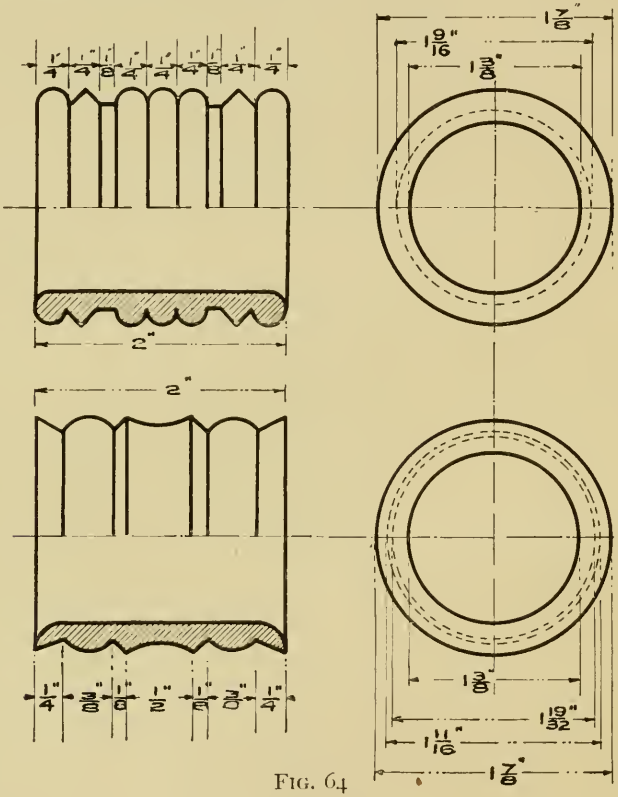


FIG. 64

inside calipers to measure with. The outside is turned next, and the ring is then sandpapered and finished, either shellac or wax finish being used.

When the ring is finished, cut it off, using the cut-off tool, and chuck it. Chuck it on what remains of the stock from which the ring was turned. This is done by turning the end small enough for the ring to slip over it snugly. After chucking, finish the end.

To make a substitute for a bell chuck. Where no bell chuck can be had, a substitute for a bell chuck may be made by using a wood face plate, turning out a hole in the center to receive the stock. To make it doubly secure, the stock may be glued into the face plate.

Sometimes such work is fastened on the screw-center chuck. When the piece is long, this method of holding it is not advisable.

EXERCISE IX. SMALL BOX

Material: Mahogany, birch, cherry

The student should always keep in mind that there is usually more than one way in which a piece of work can be made. The method given with this piece is one that is used extensively in pattern making.

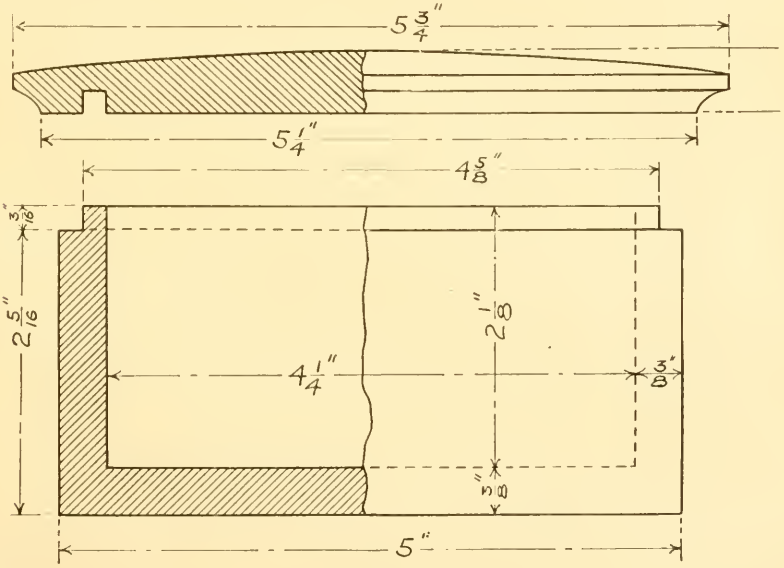


FIG. 65

Using glue and paper to mount the work. In preparing the stock for the lathe, proceed as follows: first, secure an iron face plate (two if convenient, one for the bottom, and one for the cover of the box), fasten a wood face plate to it, and turn

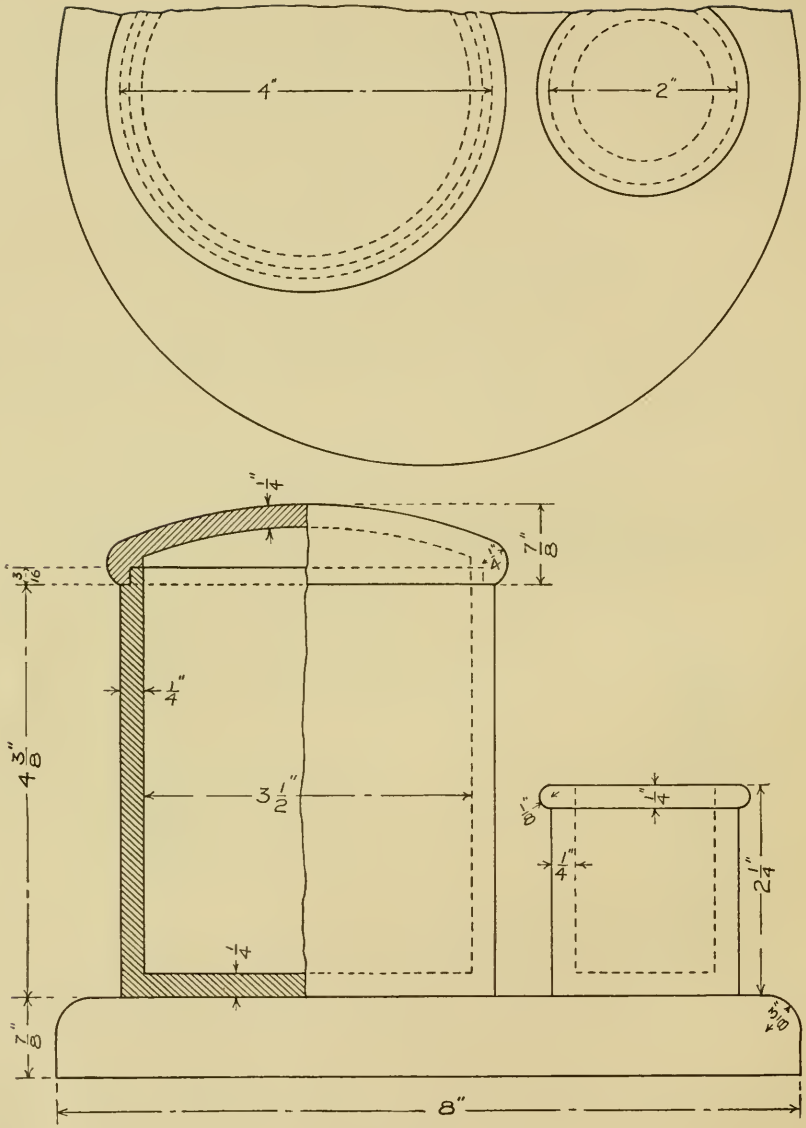


Fig. 66

it true. Cut the corners off the pieces from which the box is to be made, glue a piece of paper on the face plate, then glue the stock to the paper and clamp with a hand screw. When the glue is dry the piece is ready to be turned. Methods of turning are the same as in Exercise V. When the inside and outside of the box is turned, sandpaper, stain, and finish. (Use some of the stains and finishes given in the Appendix.)

To remove the work from the face plate. To remove from the plate, drive a chisel between the face plate and the box. The paper will split. Chuck the work on the plate to finish the bottom.

The inside of the cover should be turned first; this will be the better way, for the groove and flat surface give a better chance for chucking than the rounding side would. Finish the same as the body, then chuck it and turn the outside of the cover, and finish. The use of paper on the face plate does away with all screw holes in the work.

EXERCISE X. SMOKERS' SET

Material: Cherry, birch, oak

The design given here is only suggestive; the student may submit an original design to the instructor before undertaking to make this piece.

The methods of turning in this exercise are a combination of the methods previously given. To a great extent the pupil should rely on his own skill and ability in working out this piece.

Staining and finishing should all be done before the pieces are removed from the chucks, being careful not to get the "finish" on the parts that are to be glued to the base. Glue will not stick to varnish or shellac.

EXERCISE XI. TOWEL RAILS

Material: Birch, oak, ash, cherry, or maple

In the figure is shown the assembly drawing of this piece of work. The student should study out the pieces from it, instead of having a detail drawing of each piece.

In regard to the "arms" or pieces that support the arms, the worker will notice that they are pieces which are turned up on centers, and previous instruction will suffice for these. The balls on the supporting pieces are turned in the same manner

as that given in connection with the convex curve on the upright piece of the candlestick, Figs. 54 and 69. The curves are pared, using a right and left cut; the shape of the balls is judged by the eye instead of using a templet.

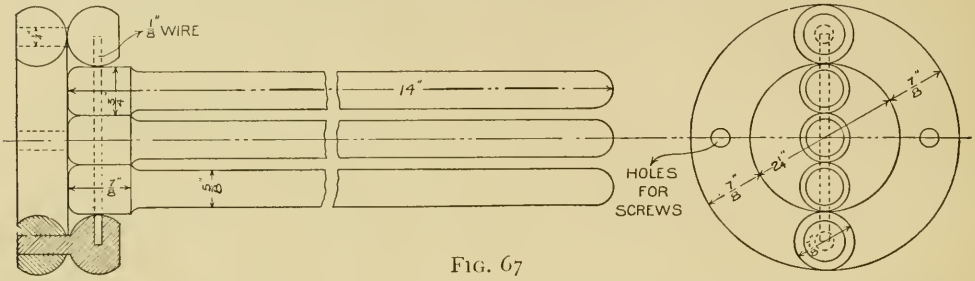


FIG. 67

To turn a ring. The ring is turned in the following manner: The stock is prepared by cutting off the corners. The face plate or screw-center chuck is then fastened directly on the piece, care being taken to see that the screws are not placed into that portion of the piece from which the ring is to be cut.

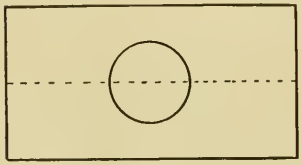


FIG. 68

To make the templet. The templet is made by boring a hole of the exact diameter, through a thin piece of stock; the piece is then cut in halves, as shown by the dotted line in Fig. 68.

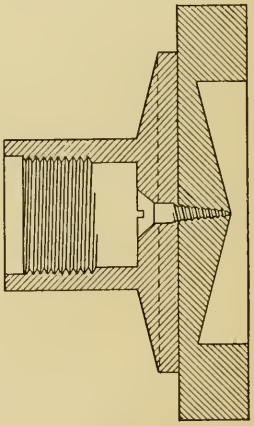


FIG. 69

When everything is ready, screw the face plate on to the spindle of the lathe, set the rest, and turn off the outside to the required diameter and also "face" off the side of the piece. The next step is to measure *in* from the outside edge the thickness of the ring, and then cut away as much of the surplus stock from the center as is possible without striking the screws. Round off the corners, using the templet frequently so that the correct shape may be obtained. In Fig. 69 is shown the piece ready for rounding.

When the ring is formed as far as it is possible to do so on the first side, sandpaper it smooth; then take it from the face plate and chuck it.

To chuck the work. The scheme of chucking will be understood from Fig. 70. When the piece is chucked, cut out the center and proceed to finish the ring. Care should be taken to see that the "section" of the ring is a true circle.

When all the rounding is done, sandpaper, and then flatten off the side as shown in the drawing. Finish by using any of the finishes given in the Appendix.

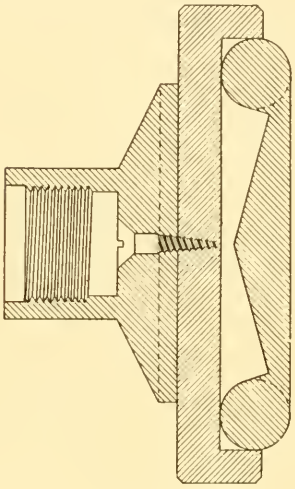


FIG. 70

EXERCISE XII. ROLLING PIN

Material: Maple

The work that follows in this manual is, to a considerable extent, a repetition of methods previously given; for this reason the sequence in which the drawings are placed need not be taken into consideration.

The rolling pin shown in Fig. 71 is commenced in the same manner as that given in connection with any piece that is turned up on centers. The stock should be a little longer than the finished article in order to get rid of the center marks on the ends. (The worker will observe that the larger the cylinder, the larger the skew chisel should be, to make the paring cut.)

After the piece is turned to its largest diameter, lay off the distances for the handles and cut off most of the surplus stock with the gouge, after which cut the

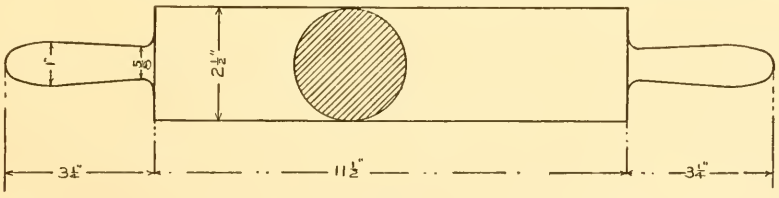


FIG. 71

handles to their largest diameter and then form them by cutting with the gouge, being careful that the side of the gouge does not dig into the end of the body of the roller.

When all the cutting is done, finish with No. 1½, No. ½, and No. 0 sandpaper, after which remove from the lathe and finish off the ends of the handles at the bench.

No oil or varnish of any kind is used on this piece of work. A screw eye may be put into the end of one of the handles to hang it up by.

EXERCISE XIII. POTATO MASHER

Material: Maple

The methods applied on this exercise are practically the same as those given in Exercise XII.

In this piece of work long convex curves and short concave curves are the special features. All the cutting may be done with the gouge, with the exception

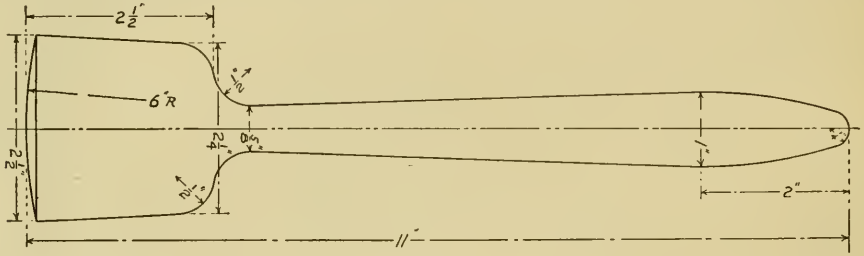


FIG. 72

of the ends which require the chisel to finish, or both the gouge and the chisel may be used on the side.

Finish with No. 1½, No. ½, and No. 0 sandpaper. (Neither oil nor varnish is to be used on this piece.) When the work is finished on the lathe remove and trim the ends at the bench.

EXERCISE XIV. CARD RECEIVER

Material: Cherry, oak, mahogany, birch

In work of this character it is advisable to use a templet for both the outside and inside. As before stated, when a templet is used, two points are required as guides in placing it. In making the templets use thin stock, long enough to

reach across the work so that a bearing may be had on both sides of the piece. Figs. 56 and 59 show templets bearing on the two points. The outer edges of the card receiver would be the points of contact for the templets in this case.

In preparing the stock for the lathe the material should be mounted on a wood face plate fastened to the regular iron face plate. To do this the method and

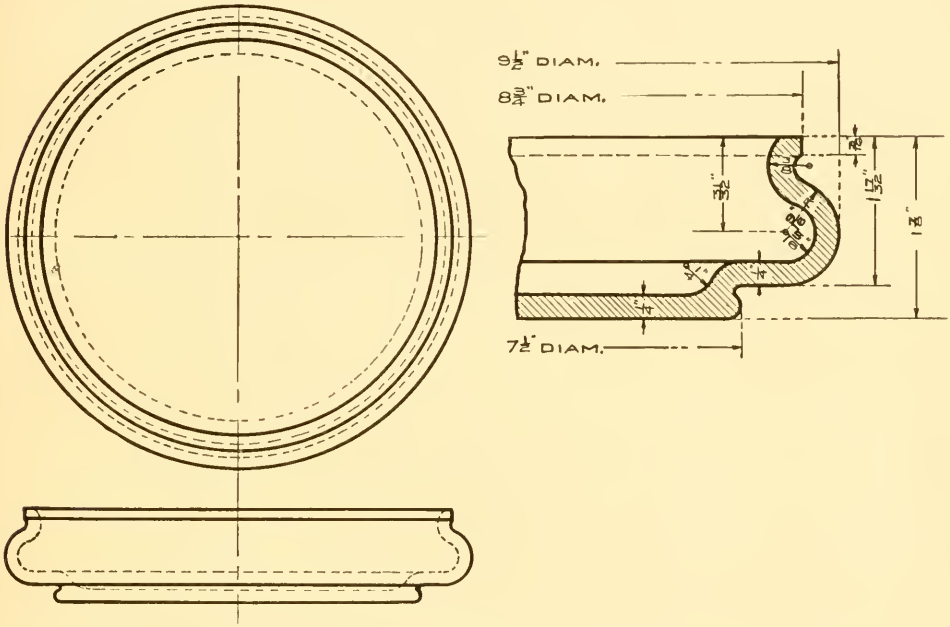


FIG. 73

instructions given in connection with the box on page 39 should be followed; that is, glue to plate with paper between.

When the piece is finished and sandpapered, it will be better to chuck it in order to smooth off the bottom, although this is not absolutely necessary, as the bottom may be finished off with the plane at the bench.

The finish and stain to be used will depend on the kind of wood. The different stains and finishes will be found in the Appendix.

SUPPLEMENTARY EXERCISES

Many useful and ornamental pieces of work can be turned out on the speed lathe; light- and dark-colored woods in combination, formed into designs, are often used to produce effects on turned work that are artistic; and the student is advised, whenever possible and time permits, to design and build up pieces of such work where the contrast between the woods will be marked. The results will more than compensate for the trouble and work of glueing up the stock.

In preparing stock for such work the surfaces should be planed to a perfect fit before being glued together, as a poor joint would be likely to ruin the work while being operated on in the lathe.

In the following supplementary exercises there has been no effort made to introduce what is usually termed "fancy turning," such as the turning of elliptical forms, turning balls inside a ball, turning loose rings on a spindle, trefoils, and work which requires much manipulation in chucks. The projects selected are ones which the average student should be able to carry out successfully, in view of his previous experience. Students are advised, at this stage, to submit original designs to the instructor in charge, that the difficulties connected with the execution of these pieces may be made subjects for class discussion.

The exercises, Figs. 74 to 87, are intended to supplement previous work, and are also suggestive for larger pieces and practice in developing speed in turning out work on the lathe.

The names of the following pieces are given as suggestions for the student to design. When a large piece is turned, it is rarely turned from solid stock, but is built up. In designing a piece this should be taken into consideration, so that the joints may not be too conspicuous, unless the woods were light and dark, when the joints should be absolutely symmetrical with the axis of the piece.

Names of pieces. Piano stool (may be combined with a piece of bench work), legs for colonial table (the top and shelf would be bench work), serving trays, bread boards, table mats, candlesticks, bowls for nuts, rose jars, vases, spindles for furniture, legs for pieces of furniture, pedestals, base and pen rack for ink stand, foot rests, game boards, circular hand mirrors, collar and cuff box, jewel boxes, walking sticks, match safes, etc.

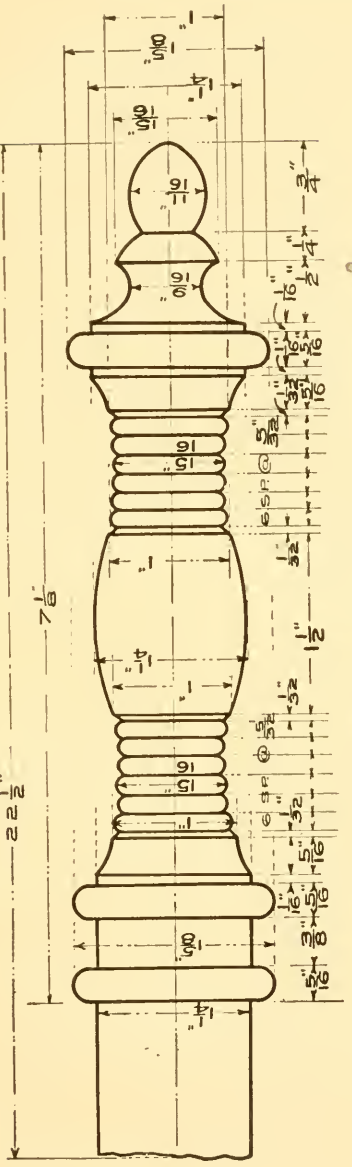


FIG. 74. POLICEMAN'S CLUB. (Material: Locust, Greenheart)

Lack of space requires that the figure be cut in its length. The principal part of this project being the handle, it is shown only for the beads. The tongue is straight work and should be finished with a paring cut. Finish the piece with two or three coats of linseed oil, and polish with a soft cloth

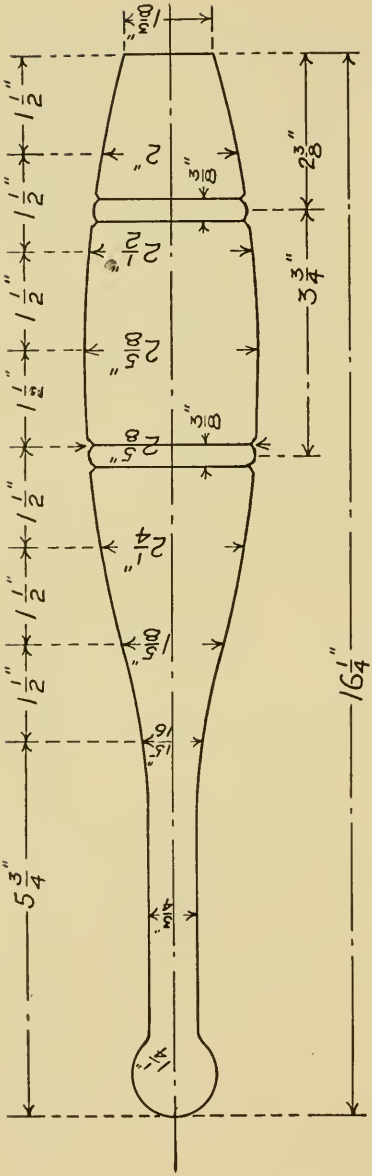


FIG. 75. INDIAN CLUB. (Material: Maple, Ash)

In cutting this piece to form, "size" the several diameters as explained in connection with the chisel handle, then cut down to the points. This method is termed "turning by ordinates."

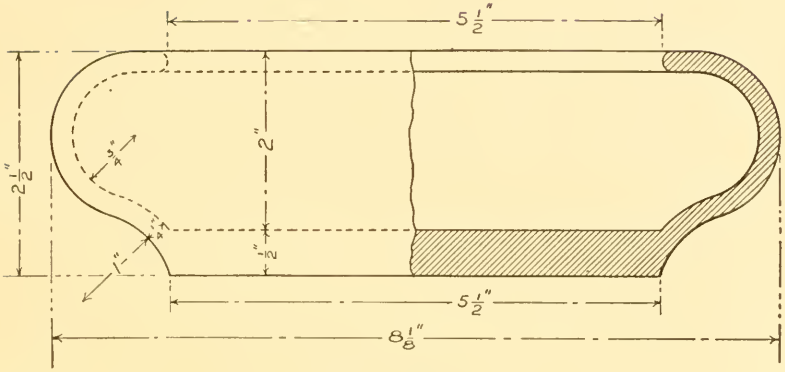


FIG. 76. BOWL

(Material: Birch, Oak, Walnut)

This piece should be mounted on a face plate with glue and paper, and templets should be used to cut by. This article is very useful on a library table as a catch-all, and if for any reason a cover is needed for it, one may very easily be designed. Finished in dark mahogany it presents a very pleasing effect

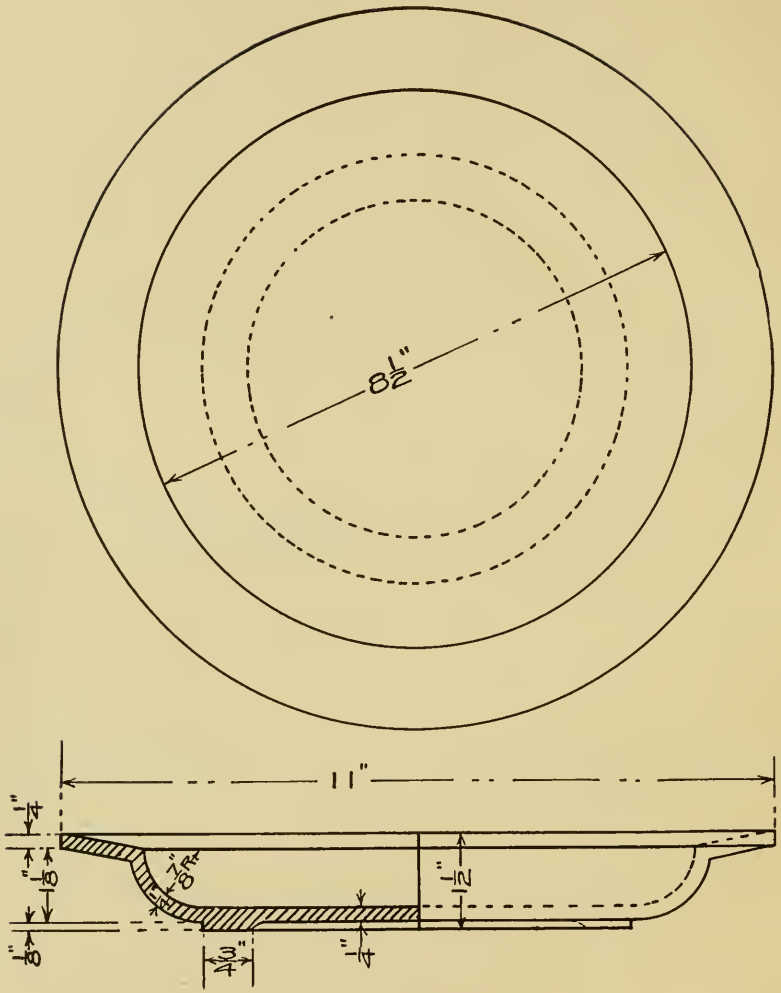


FIG. 77. PLATE

(Material: Black Walnut, Maple, Cherry, Mahogany, Oak)

Use glue and paper to hold the material on the face plate, and templets to work by

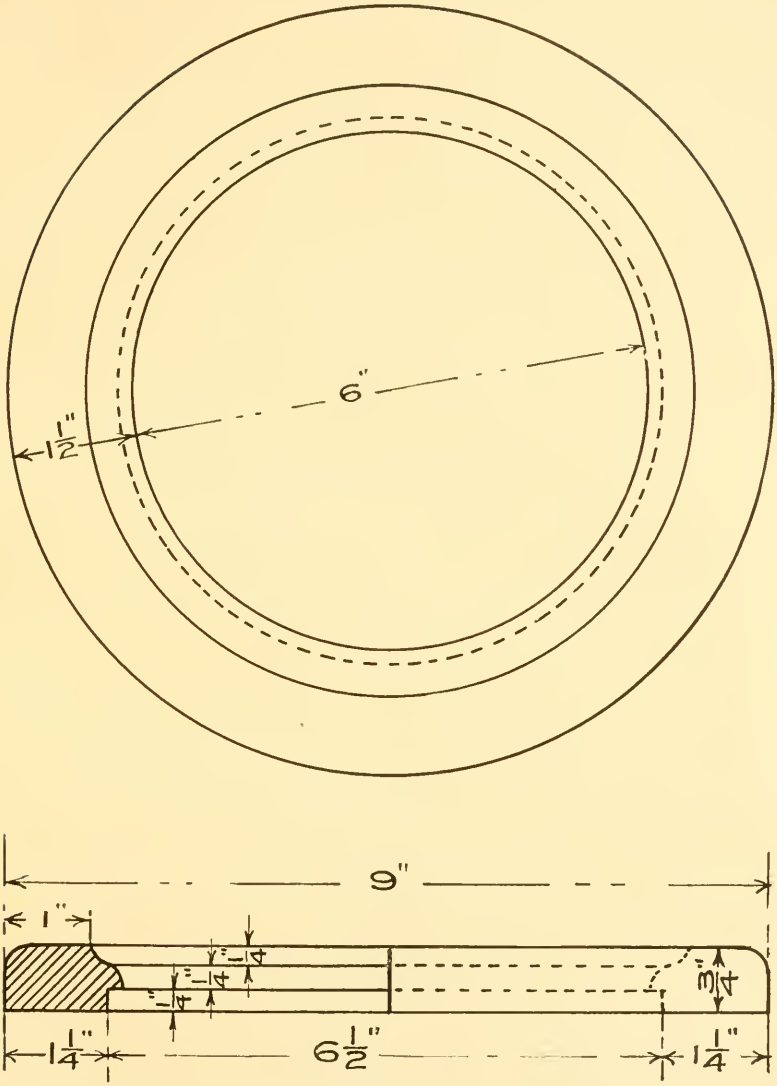


FIG. 78. PICTURE FRAME

(Material: Birch, Mahogany, Oak, Cherry)

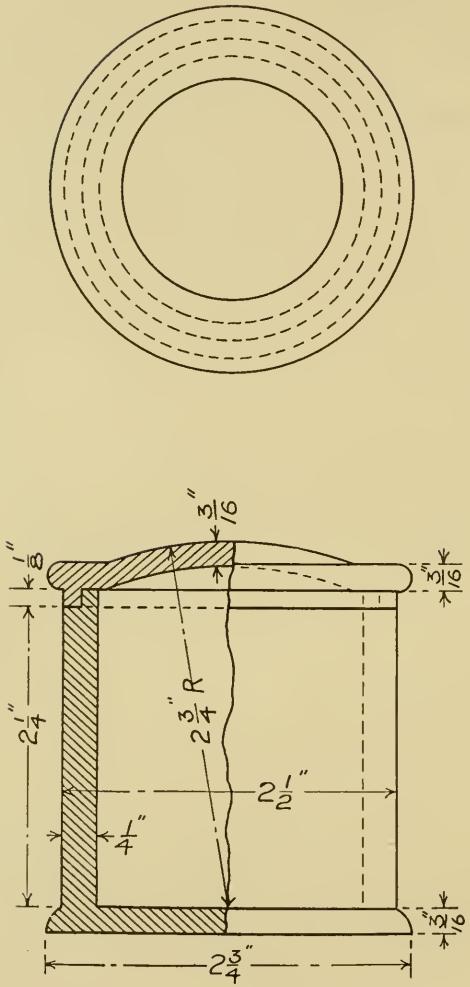


FIG. 79. POWDER BOX. (Material: Oak, Cherry, Mahogany)

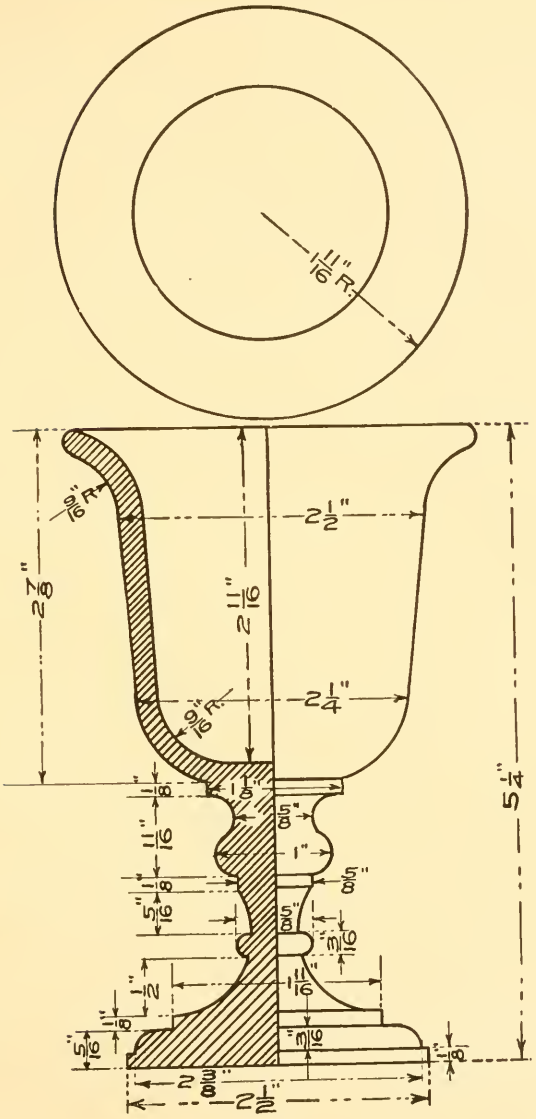


FIG. 80. CUP. (Material: Oak, Cherry, Birch, Walnut, Mahogany)

An attractive piece of work may be made of this, if built up of a combination of colored woods

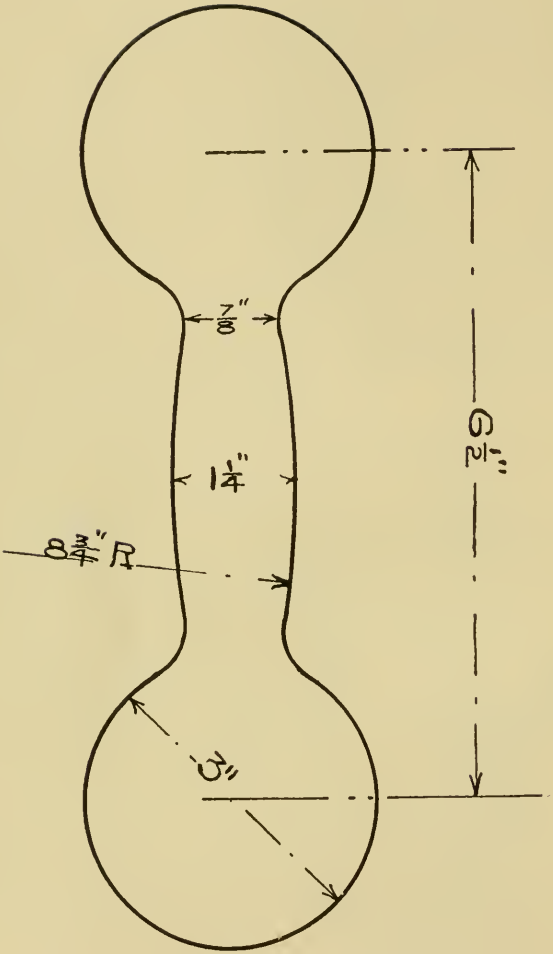


FIG. 81. DUMB-BELL. (Material: Maple)
Use a templet to work by

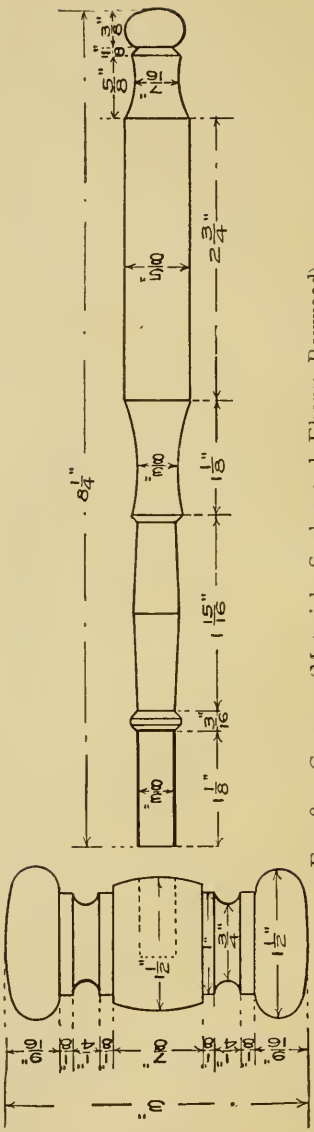


FIG. 82. GAVEL. (Material: Snakewood, Ebony, Boxwood)
Give a thin coat of shellac, and when dry smooth with fine sandpaper and polish with wax

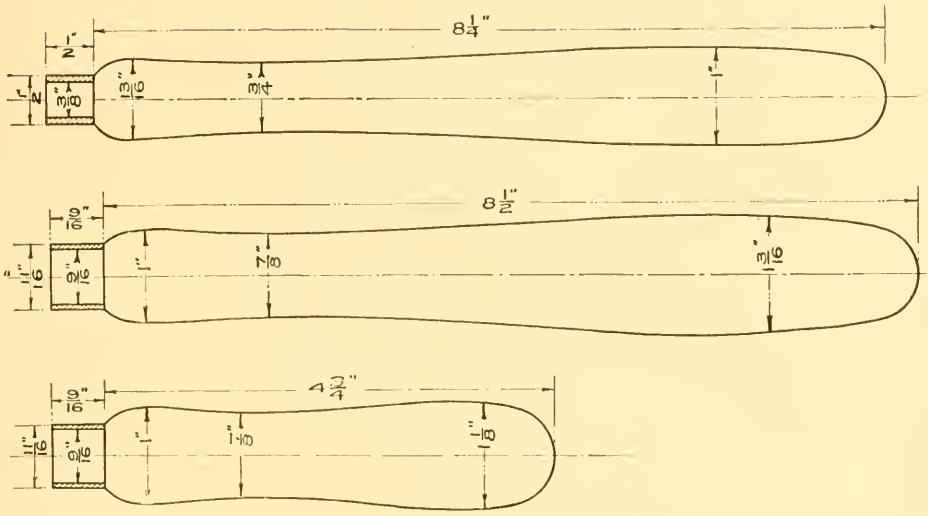


FIG. 83. TURNING TOOL HANDLES. (Material: Hickory, Apple)

Lathe tool handles are often broken by accident and must be replaced. In turning a handle, the size of the tang of the tool should be taken into account when procuring the ferrule. The drawings given above are for handles suitable for a $\frac{1}{8}$-inch cut-off tool, a $\frac{1}{4}$-inch or $\frac{3}{8}$-inch skew chisel or gouge, and a $\frac{1}{2}$-inch or $\frac{3}{4}$-inch skew chisel or gouge. For larger tools the handles should be increased a little in diameter but not in length

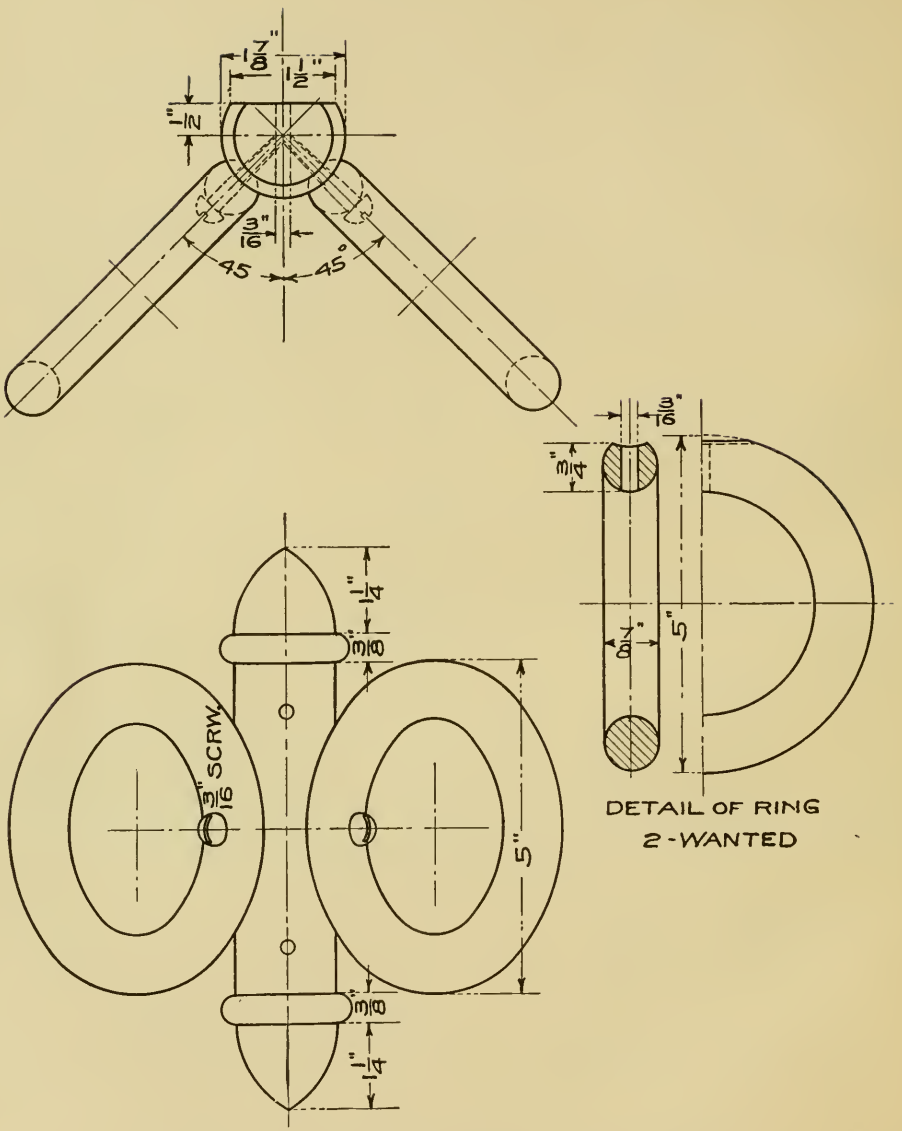


Fig. 84. Towel Rings. (Material: Cherry, Maple, Birch)

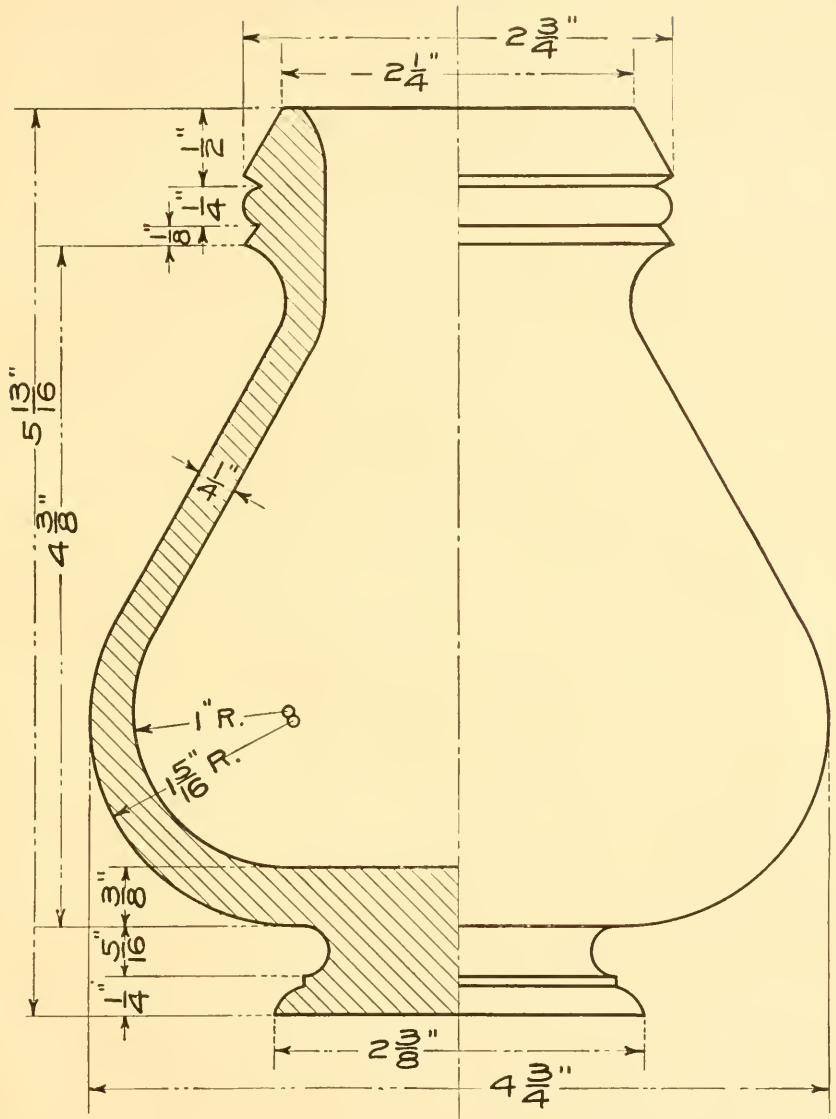


FIG. 85. VASE. (Material: Whitewood, Birch, Cherry, Mahogany, or build up of light and dark woods, such as Cherry and Black Walnut)

Use the bell chuck

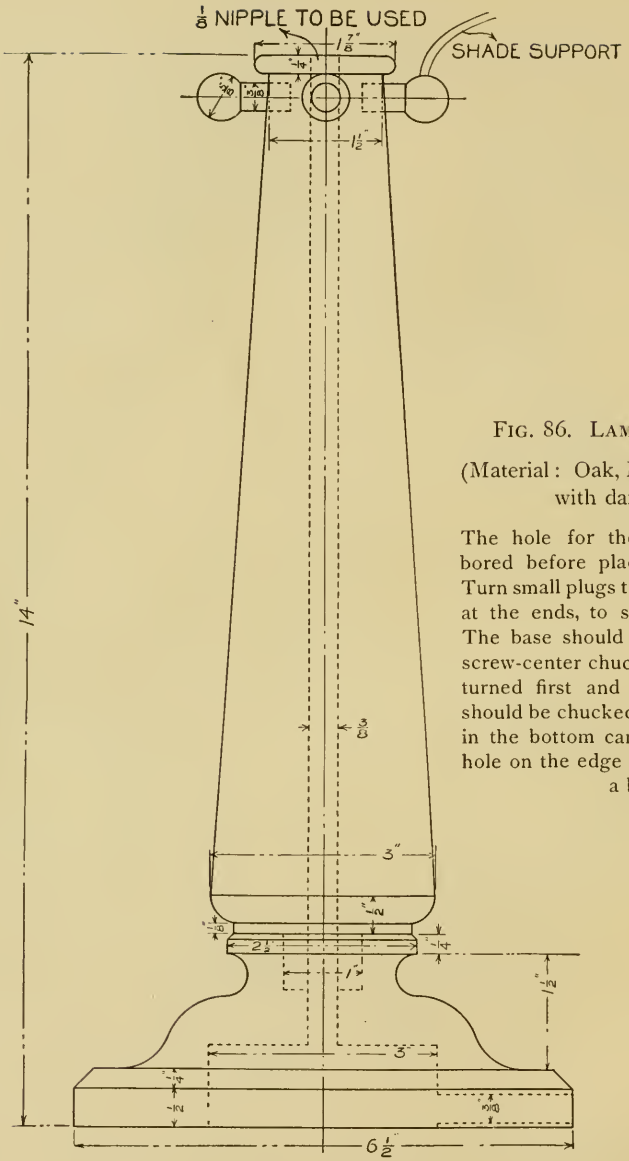


FIG. 86. LAMP STANDARD

(Material: Oak, Mahogany; finish with dark stain)

The hole for the wire should be bored before placing in the lathe. Turn small plugs to place in the hole, at the ends, to support the piece. The base should be mounted on a screw-center chuck; the upper side turned first and finished; then it should be chucked so that the recess in the bottom can be turned. The hole on the edge will be bored with a bit

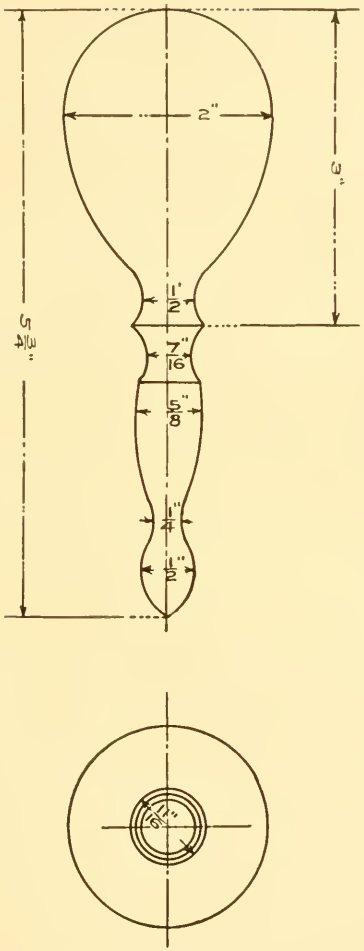


FIG. 87. STOCKING AND GLOVE DARNER

(Material: Maple, Cherry, Birch, or build up of light and dark colored woods)

PARTED OR SPLIT WORK

Methods for turning a piece of "split" work, such as would be used for decorative purposes on flat surfaces. In Fig. 88 is shown a piece that is semicircular in section, such as would be used in connection with moldings on flat surfaces, where they are "planted on" as decorations.

In some cases it is customary to finish the end of a straight piece of molding with a "final," such as is shown in the figure. In order to produce this piece so that one side will be flat, several methods are made use of in preparing the stock for the lathe. (*These methods are also used on such work as turned pilasters and*

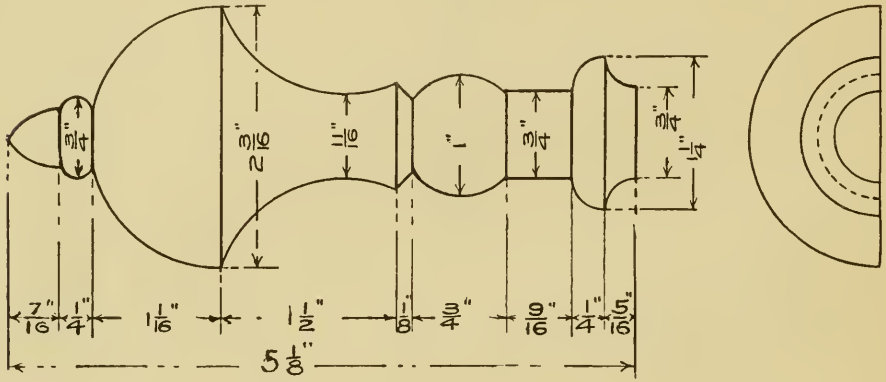


FIG. 88

on parted cylindrical patterns.) For convenience the methods are numbered, No. 1 being given the preference, as in most cases it saves time but uses a trifle more stock.

As indicated in the cuts, two pieces of stock are used in working out problems of this kind. The surface of each piece should be planed true before being fastened together.

Method 1. Fig. 89 shows this method where screws are made use of to hold the pieces together. That part of the stock in which the screws are placed should be outside of the exercise so that there will be no holes in the work when finished.

Method 2. In Fig. 90 is illustrated the method where glue and paper are used to hold the pieces together. The glued surfaces should be outside of the exercise, as indicated in the figure.

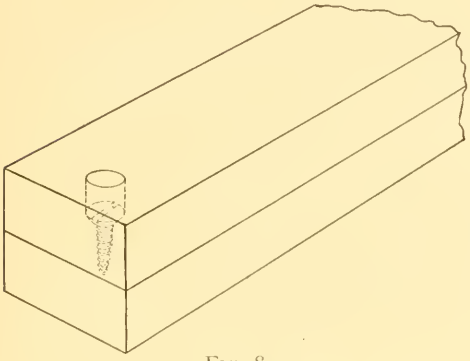


FIG. 89

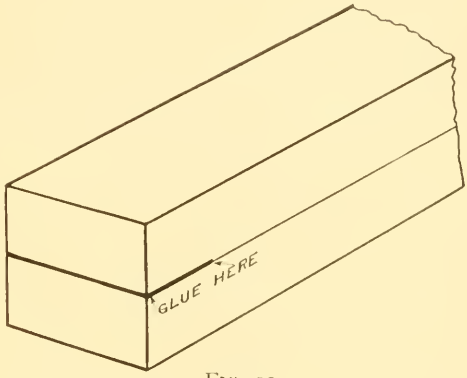


FIG. 90

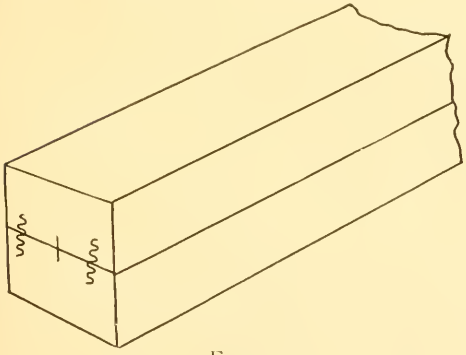


FIG. 91

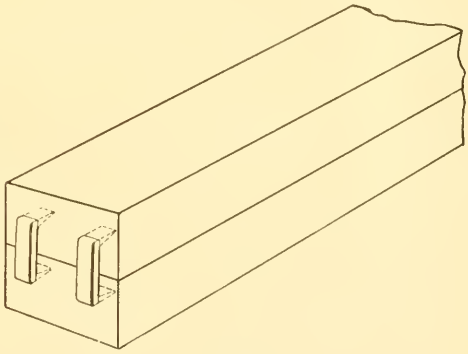


FIG. 92

Method 3. Fig. 91 illustrates a method where corrugated nails are made use of, and for very light work this method is an excellent one.

Method 4. Fig. 92 illustrates a method where pinch dogs are used, and in connection with method No. 1 is often used on heavy work.

Method 5. Where much of this character of work is done, special attachments are used on the lathe, which are practical and time-savers. These attachments can

be made of wood in connection with the face plate. Fig. 93 shows the attachments. The pieces from which the work is to be turned should be fitted snugly between the jaws of the chucks. The screws shown are filed sharp, the work is driven between the jaws, and the points of the screws hold it from slipping sidewise. For the dead-center end, a cone center and a small plate fastened to the wooden plate make a serviceable chuck. These chucks can be made of cast iron, and would be valuable additions to any wood-turning room equipment.

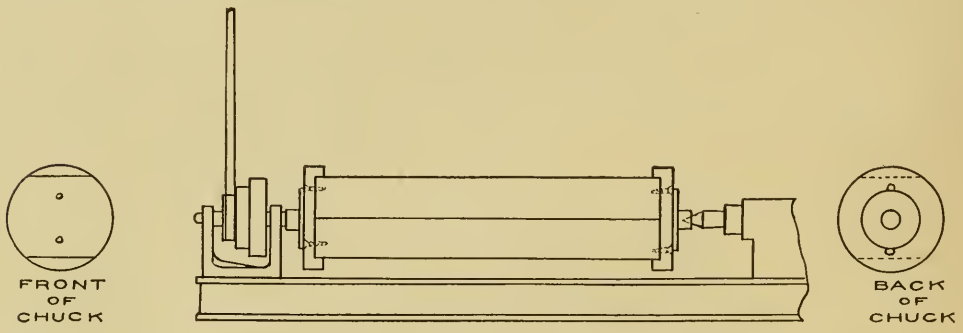


FIG. 93

MISCELLANEOUS TURNED MOLDINGS

Possibly there is no more fascinating work on the lathe than that of "rolling" a bead or cutting a "hollow." Often the beginner, after having had a little practice on the lathe, is at a loss for some design to practice on and work out.

In order that the pupil may have something to guide him, the "plates" of turned moldings have been added to this manual, and in them may be found combinations of beads and fillets of almost any design.

From the designs an instructor may arrange a series of exercises for practice in the paring of beads and hollows, or, if turned up in long lengths, the molding can be used in the decorating of corners or flat surfaces. Some of the designs could be enlarged and used as chair spindles and legs. The designs are also suggestive for grill work and fire-screen panels.

In using the designs for exercises the material should be close-grained wood, such as whitewood or red gum. Pieces for spindles, legs, or moldings should be stained and finished before the center ends are cut off. It is easier to finish such pieces on the lathe because of the irregularity of the surface.

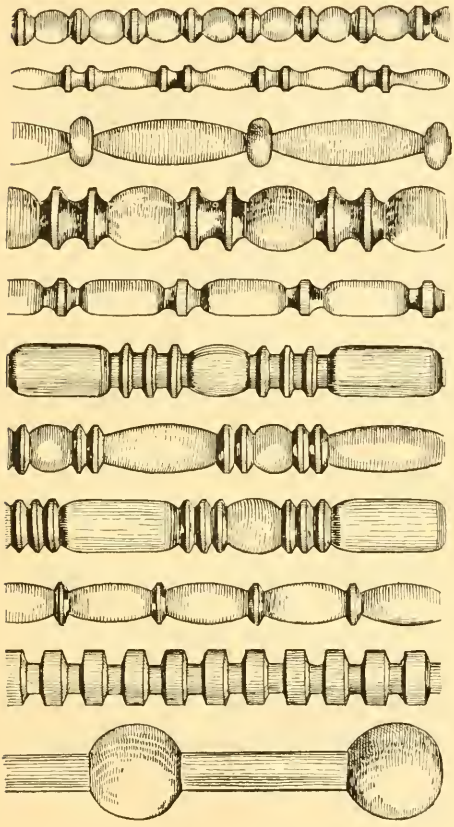


PLATE I

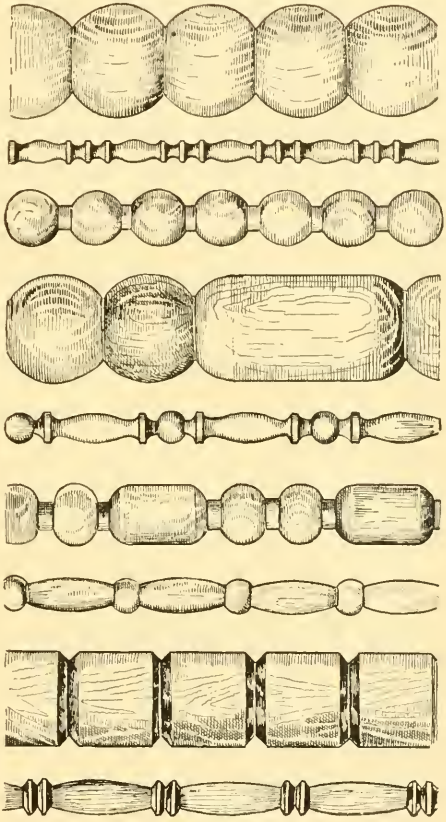


PLATE II

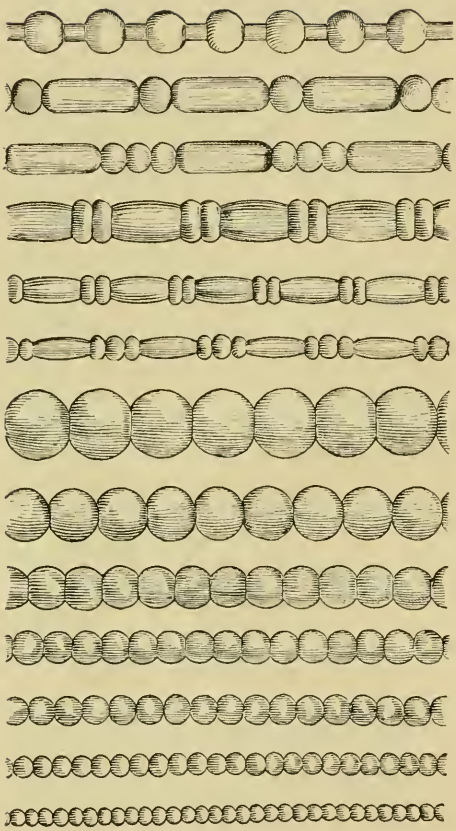


PLATE III

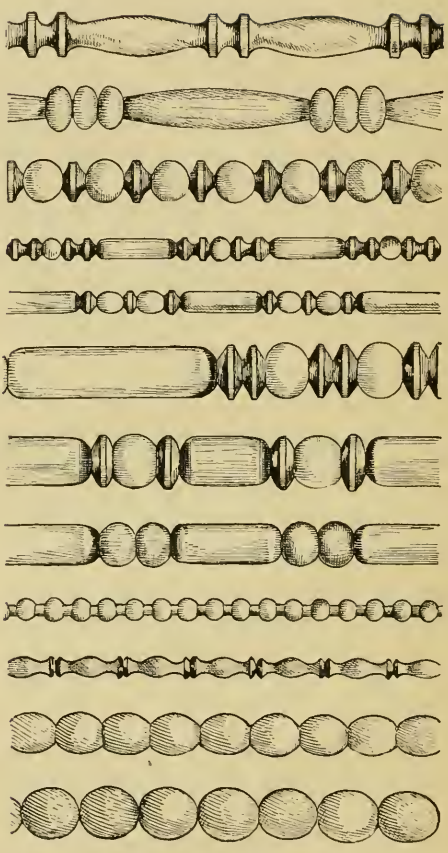


PLATE IV

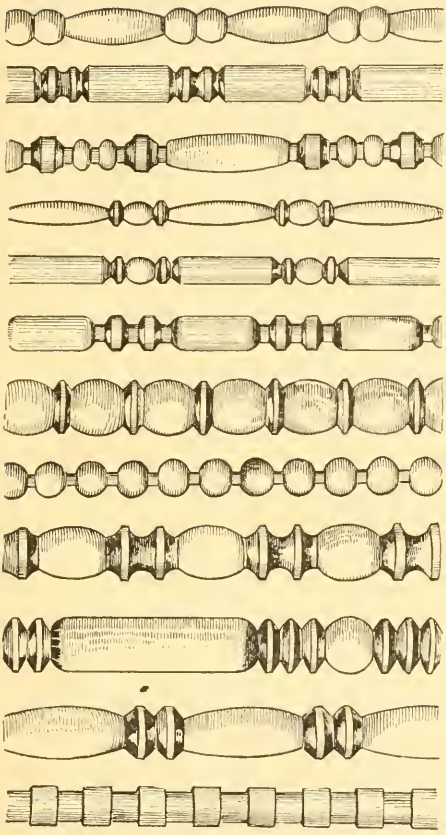


PLATE V

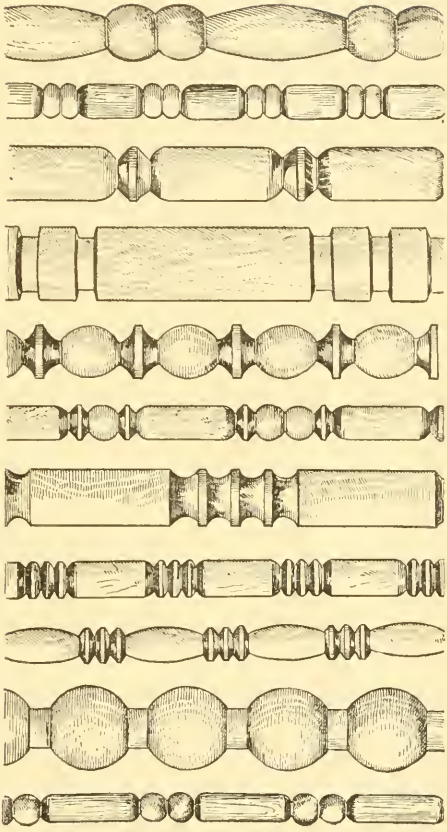


PLATE VI

APPENDIX

There has possibly been no greater progress made in any art in the past few years than that which has been made in the art of staining and finishing woods. This, we believe, is to a great extent the result of the "Arts and Crafts" movement, which has brought out many new shades in dyes and stains, and new methods of finishing.

There are on the market many beautiful stains and finishes which give pleasing results, but to the pupils who wish to make some experiments of their own the following recipes are given.

It should always be kept in mind that a small piece of work is much more easily finished than a large piece; especially is this true when water or spirit stains are used. Any one using these stains should be careful to have them applied in such a manner that the staining will not show laps. This difficulty is not met with in using oil stains, as they do not dry out so quickly as the others.

The materials used in staining are many, and may be divided into five classes; namely, alkali, aniline, acid, mineral, and vegetable stains. Some colors are of such a nature that they fade and necessitate "setting," or "fixing," with a mordant. The materials mostly used to fix a color are sulphate of iron, commonly known as green vitriol or green copperas, and alum. The quantity to use for a solution is two ounces of either copperas or alum to a quart of water. Place the material in a cloth and suspend it in the water where it will readily dissolve. Copperas is also used in connection with the ebonizing of wood.

The following list of stains and finishes does not exhaust the subject, but these are given as the most simple ones for the beginner to use.

Before applying a stain or finish of any kind, the wood should be thoroughly smoothed with tools and sandpapered. Hard woods should be planed, scraped, and sandpapered, thus eliminating all rough and dull-looking spots. This is absolutely necessary in order to obtain a good "finish."

There are possibly no more simple finishes to apply than linseed oil and finishing wax.

To finish with linseed oil. When the work is thoroughly prepared, apply a coat of linseed oil and allow it to stand for a time, then rub with a soft cloth. Let the work dry and then apply another coat of oil. Repeat the operation five or six times. When the oil is thoroughly oxidized, rub with a cloth until a gloss is obtained. In fact, the time never comes when a little more rubbing will not improve a surface finished with linseed oil.

This finish has a quality that is greatly overlooked; namely, that it is not easily marked with hot dishes or water.

To finish with wax. Finishing wax can be applied on almost any stain, or it can be applied directly to the wood. When it is rubbed down it gives a dull gloss. It is a rather soft finish, is easily marred, but has the advantage in that it can be refinished without much trouble.

Apply the wax on the article with a cloth, let it stand for a few minutes, then rub off with a soft cloth. To polish, use a fairly hard brush. To refinish, repeat the above operation.

To make finishing wax. Cut beeswax into small pieces, and, with twice as much turpentine as there is wax, place in a vessel and apply a moderate heat which will help to soften the wax.

The vessel should not be placed over the fire.

The wax should be of the consistency of vaseline; if too thick, thin with turpentine.

To finish with shellac. In using shellac care should be taken to see that the solution is not too thick; when too thick, thin with alcohol.

In finishing a turned piece, brush on a fairly heavy coat of the shellac varnish; then, while the lathe is in motion, rub the surplus off with a cloth, before it hardens. This will give a good finish for chisel handles and similar articles.

On flat surfaces the shellac should be brushed evenly and not too heavy. To obtain a glossy surface, three coats are necessary. After each coat the surface should be smoothed with fine sandpaper (using No. oo) before applying the next.

To rub a shellacked surface, use felt, and rub down with powdered pumice and water. To polish the surface of a piece on the lathe, use shellac and oil, being careful not to use an excess of either. A little experience will determine the exact amounts.

To cut shellac. Put any quantity of gum shellac in a vessel (either earthen or glass, but *not tin or iron*), cover it over with alcohol, stir it frequently. It will take about four to eight hours to reduce the gum to liquid form.

To lighten shellac. Shellac will become dark colored when kept in a tin or iron vessel. To clear it, add about one heaping teaspoonful of oxalic acid to a quart of liquid shellac. It is not advisable to use the oxalic acid often in the same solution, as the mixture deteriorates.

To finish with varnish. Usually a surface that is to be finished with varnish is first filled (see Filler) after staining, or the filler may be colored, thus staining and filling with one operation.

After the surface is filled, the pores of the wood should be sealed; it is found best to seal them by applying a coat of shellac. After the shellac is dry it is smoothed with sandpaper, and then a coat of varnish is put on and allowed to dry. (A mistake usually made on varnished surfaces is, that each coat is not allowed to dry sufficiently before the next

coat is applied.) Before putting on a fresh coat of varnish the surface should be smoothed with either No. 00 sandpaper or haircloth.

When the required number of coats are spread on the work and dried sufficiently, the surface can be left glossy, or it can be rubbed with powdered pumice and water, giving an eggshell gloss, or it can be polished. To polish, rub with pumice and water, then polish by rubbing with rotten stone, finally using finely powdered chalk. Give the surface a final rubbing with the bare hand and clean off with a piece of chamois skin or soft silk. A little experience is necessary to determine how much rubbing is required. The condition of the work will usually determine this.

Fillers. Ready-to-use fillers can be obtained in the open market; they save time.

Many materials are used as a base in the making of fillers, such as whiting, cornstarch, silex, flour, etc. The material which we believe to be the best is silex.

To make light fillers. To make the filler, take a quantity of silex and mix it with linseed oil into a stiff paste; then add a small quantity of Japan drier in the proportion of one tablespoonful to one quart of paste. Mix thoroughly, thin to the proper consistency with turpentine or benzine, and apply with a brush; let it "set" for a time, then rub off with excelsior or burlap, and finally rub with waste or a soft cloth. The filler should be left to dry for at least twenty-four hours before the first coat of shellac is applied.

To color filler. A golden oak stain and filler is made by adding to the above raw sienna and a little burnt umber. A dark filler is made by adding to the light filler burnt umber and drop black. A green filler is made by adding to the light filler chrome yellow and Prussian blue. Almost any shade or color can be had by using combinations of pigments with the light filler.

Stains. In using chemicals to stain woods it will be found that different pieces of the same kind of wood will take different shades; especially is this true in regard to oak.

To obtain an *olive green on oak*, use a saturated solution of iron chloride. When the wood comes out light a solution of tannic acid will darken it. Judgment must be exercised in the use of the tannic acid in respect to the strength of the solution. This will depend on the hardness and color of the wood. Different shades of green can be had by different strengths of solution.

To obtain a *rich deep brown on oak*, use iron chloride, and on that apply ammonium sulphide. If pieces in the work should be lighter, use tannic acid to darken.

To color *whitewood a deep brown*, first give a coat of tannic acid (five per cent solution), then a coat of iron chloride, then ammonium sulphide. Treat ash in the same manner (for brown) as whitewood.

To *darken mahogany*, use a five per cent solution of bichromate of potash. This will age it. When the bichromate solution is dry on the work, coat with a solution of red

sanders. Bichromate solution is made from the crystals dissolved in water. The depth of color required will determine the strength of the solution. Red sanders solution is made by extracting the color from the powdered red sanders in alcohol. The depth of color required will determine the strength of solution.

To produce an *old mahogany stain* on mahogany and cherry, coat the work with a solution of bichromate of potash or ammonia, and, when dry, give it a coat of filler made in the following manner:

To make *mahogany filler*, add rose lake and drop black to light filler, and apply the same as ordinary filler.

To *darken oak*, use common lime made into a thin paste and apply. Let it stand a few minutes and rub off; if not dark enough, repeat the operation.

A rich *brown* is obtained by the use of iron chloride, ammonium sulphide, and burnt umber. The umber is made by mixing some of the powder in linseed oil and turpentine, or the umber ground in oil, thinned with turpentine, can be used. Apply in the order given above.

All work should be rubbed off with a soft cloth after oil or oil stain is applied. On all work where water or spirit stains are used, an oil-stain effect can be obtained by coating with linseed oil.

Fuming oak and other woods. The effect of fuming with ammonia is different on different woods (a little experimenting by the pupil will be of interest); especially is this true of oak. Red oak will not give such good results as white oak, and so it is with other woods.

In fuming, the work should be free from all grease or oil spots. The surfaces that are to be stained should be kept clear of all other surfaces, to allow free circulation of the fumes of the ammonia.

The work is placed in an air-tight box; an open vessel containing ammonia is also placed in the box with the article. The work is left until the desired color effect is obtained; a beautiful soft stain is the result.

To stain wood *black*, brush the wood over several times with a hot solution of logwood, and, when dry, apply a coat of a preparation made from powdered galls. Finish with wax. The logwood solution is made by boiling the logwood in water. The gall solution is made by using two ounces of powdered galls to one quart of water. The galls should be allowed to stand in the water from three to four days; a mild heat should be applied during this time.

Another method of ebonizing wood is to give the work a coat of extract of logwood (the hotter the better), and, when dry, apply a coat of acetate of iron (which is made by putting iron filings in vinegar or in a five per cent solution of acetic acid). After the second coat is dry, apply a coat of a solution made of sulphate of iron (two ounces to a quart of water).

A third method of ebonizing wood is to apply three or four coats of extract of logwood; develop the color by going over the work with a tincture of muriate of iron.

Another method of ebonizing wood. Boil one half pound of logwood in two quarts of water, add to this the peel or shells of walnuts, weighing about four ounces. Boil a second time and strain, then add one half pint of good vinegar and apply to the work when hot.

Aniline stains. From aniline dyes almost any color and shade can be obtained by combinations. Some of the colors are soluble in alcohol, some in water, and others are soluble in either water, alcohol, or turpentine.

In mixing for different shades, therefore, the liquid in which the color is soluble will determine which can be mixed together. Some of the colors require a mordant, and a solution of alum, vinegar, or copperas may be used.

The method of making a mahogany aniline stain is as follows: bismarck brown, ½ oz.; boiling water, 3 pt.; or bismarck brown, ½ oz.; alcohol, 3 pt.

All other aniline stains are made in this manner, substituting the liquid in which they will dissolve. Aniline stains should be kept in bottles, labeled, giving strength of solution (water, alcohol, or oil), so that no mistake can be made in using it.

Miscellaneous recipes. 1. *Mahogany.* Fustic chips, 2 oz.; madder root, ¼ lb.; water, ½ gal.

2. *Mahogany.* Dissolve archil in water and make it of such strength as will suit; add a little eosin, and apply to the work cold.

3. *Mahogany.* Boil logwood chips in twice their bulk of water for two hours. Strain, then add a small quantity of chloride of tin. The tin gives redness. The quantity of tin to be used will depend upon the color required. Give the work two coats.

4. *Walnut.* Epsom salts, ¼ oz.; permanganate of potash, ¼ oz.; water, ½ pt. Dissolve, strain, and apply; repeat until dark enough to suit.

5. *Walnut.* Vandyke brown, 4 oz.; lye or potash, 2 oz.; water, 1½ lb. Boil until the bulk is reduced to less than half, and apply with a cloth when cold.

6. *Walnut.* Vandyke brown, 1 oz.; burnt umber, ¾ oz.; aqua ammonia, ¼ lb. Mix and apply after straining. Let the work stand for a time to get rid of the ammonia fumes.

7. *To make a rosewood stain.* Boil one quarter of a pound of logwood in one and one-half pints of water, then add one quarter of an ounce of salts of tartar. Stain the work with this solution while it is hot. Give two or three coats. To develop the grain of rosewood, take a stiff brush and streak with the ebony stain previously described, using a piece of rosewood as a pattern for the grain.

8. *Rosewood.* Any of the mahogany stains will make a rosewood stain if repeatedly applied. If stained to a dark mahogany tone, go over the work lightly with an ebony stain,

using a camel's-hair brush. Go over the work in a straggling, haphazard way, which is peculiar to the grain of rosewood.

9. *Cherry.* Any of the mahogany stains will make a cherry stain if thinned.

10. *Dark oak.* Burnt umber, 4 oz.; aqua ammonia sufficient to make stiff paste. Thin until the desired shade is obtained.

11. *To brighten stains.* Nitric acid, $\frac{1}{2}$ oz.; hydrochloric acid, $\frac{1}{8}$ oz.; grain tin, $\frac{1}{2}$ oz.; rain water, 1 oz. This should be mixed a few days before using.

12. A beautiful brown is obtained on whitewood and birch by using, first, extract of logwood, allowing it to dry, and then adding a coat of acetate of iron. Rub off with a soft cloth and finish with wax.

Recipe for refinishing varnished surfaces. In staining and finishing woods a student is liable to make mistakes in the color wanted. Many times, if the work could be refinished, it would be more satisfactory to him.

The following recipe for cleaning off varnish and filler, and bleaching the wood to its natural color, will be found to give very satisfactory results:

Clean off shellac and varnish with varnish remover. Varnish remover is obtained in the open market from dealers in paints and varnishes.

After the surface has been cleaned of varnish, wash it off with a strong solution of caustic potash or lye; then wash off with clean cold water; then wash off with the bleaching solution, which is made of oxalic acid, — a strong solution. Let this dry and wipe off with a damp cloth, when the surface will be ready to stain and finish in any desirable way.

Another solution which will remove varnish and may be made by the student with little difficulty is prepared in the following way: Mix together equal parts of soap powder or Gold Dust and caustic soda, add to this about one quarter as much ammonia as there is powder, then add water enough to dissolve the powder. Apply to the varnished surface with a cloth; wipe off the old varnish with burlap or excelsior and finish wiping with a clean cloth. (The hands should be protected.) Bleach the surface with the oxalic acid solution. Stain and finish in any desirable way.

A method of decorating work with designs on light-colored woods. Draw the desired design on the work. Shellac the design, being careful to keep the edges sharp. Give two or three coats, and after each, smooth the surface with fine sandpaper. When the shellac has thoroughly hardened, apply a coat of any desired dark stain to the whole work; the design will stand out like inlaid work.

Cement wax used in turning. A cement used in turning, to hold light and thin pieces on the lathe, is made as follows: resin, 1 oz.; pitch, 2 oz.; red ocher, finely powdered. Melt the resin and pitch together, and, while boiling, add the ocher. Use enough of the ocher to make the cement of the proper consistency; a little tallow is sometimes added to this.

By applying this cement to a chuck and heating it, a thin piece of wood can be held while being turned on the lathe. To remove the piece from the chuck, tap it lightly and it will come off with little trouble.

Another recipe for cement wax is: resin, 1 lb.; pitch, 4 oz. Melt together, and, while boiling, add brick dust; test it by dropping a little on a flat surface until it is found to be hard enough; then pour it into water and make up into rolls.

Still another may be made by melting equal parts of resin and beeswax together and allowing to cool, when it will be ready for use.

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